CONFIDENTIAL

CYL-HUB1

Construction Documents
Project Manual

BUILDING PERMIT DOCUMENTS

22 SEPTEMBER 2025

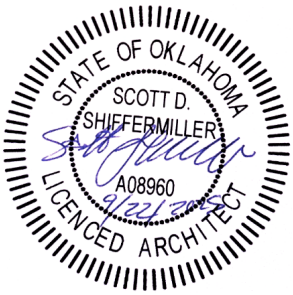
HDR Project No. 5647/10434535
DLR Group Project No. 43-25105-00

SECTION 000107 - SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

A. Architect:

1. Scott D. Shiffermiller, AIA, NCARB.
2. Oklahoma License No. A08960.
3. Responsible for Divisions 00-13 and Section 323119 except where indicated as prepared by other design professionals of record.



B. Structural Engineer:

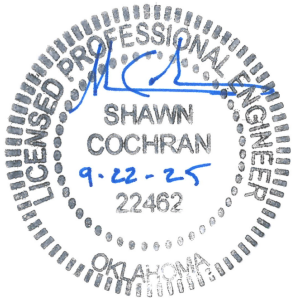
1. John Weiskopf, PE, SE.
2. Oklahoma License No. PE23869.
3. Responsible for Sections 031000, 032000, 033000, 051200 and 054000.

C. Fire-Protection Engineer:

1. FSi Engineers.
2. Responsible for Division 21.

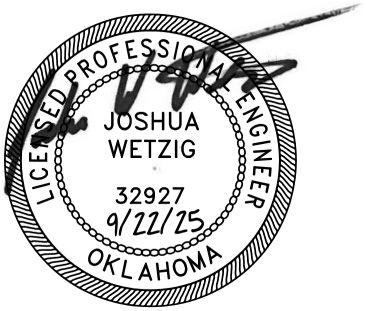
D. Mechanical Engineer, Plumbing and HVAC:

1. Shawn Cochran, PE, LEED AP.
2. Oklahoma License No. 22462.
3. Responsible for Divisions 22 and 23.



E. Electrical Engineer:

1. Joshua Wetzig, PE.
2. Oklahoma License No. 32927.
3. Responsible for Divisions 26 through 28.



END OF SECTION 000107

SECTION 000110 – TABLE OF CONTENTS

DIVISION 00 — PROCUREMENT AND CONTRACTING REQUIREMENTS

000107 SEALS PAGE
000110 TABLE OF CONTENTS
003132 GEOTECHNICAL DATA
003132A GEOTECHNICAL ENGINEERING REPORT

DIVISION 01 — GENERAL REQUIREMENTS

011000 SUMMARY
012300 ALTERNATES
012500 SUBSTITUTION PROCEDURES
012500A POST-BID REQUEST FOR SUBSTITUTION FORM
012600 CONTRACT MODIFICATION PROCEDURES
013100 PROJECT MANAGEMENT AND COORDINATION
013200 CONSTRUCTION PROGRESS DOCUMENTATION
013233 PHOTOGRAPHIC DOCUMENTATION
013233.11 DCDE CONSTRUCTION PHOTO POLICY
013300 SUBMITTAL PROCEDURES
013324 CAD BIM DOCUMENTATION REQUIREMENTS
013523 OWNER SAFETY REQUIREMENTS
013523.1 CONSTRUCTION INCIDENT NOTIFICATION
013553 CONSTRUCTION SECURITY REQUIREMENTS
013553.11 SECURITY CONSTRUCTION STAFFING AND EXPECTATIONS
014000 QUALITY REQUIREMENTS
014200 REFERENCES
014554 BUILDING ENVELOPE AIR BARRIER TESTING PROCEDURES
015000 TEMPORARY FACILITIES AND CONTROLS
015110 SITE TEMPORARY POWER REQUIREMENTS
016000 PRODUCT REQUIREMENTS
016400 OWNER-FURNISHED PRODUCTS
017300 EXECUTION
017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
017700 CLOSEOUT PROCEDURES
017823 OPERATION AND MAINTENANCE DATA
017836 WARRANTIES
017839 PROJECT RECORD DOCUMENTS
017900 DEMONSTRATION AND TRAINING
019113 GENERAL COMMISSIONING REQUIREMENTS

DIVISION 03 — CONCRETE

031000 CONCRETE FORMING AND ACCESSORIES
032000 CONCRETE REINFORCING
033000 CAST-IN-PLACE CONCRETE
034500 PRECAST ARCHITECTURAL CONCRETE

DIVISION 04 — MASONRY

042200 CONCRETE UNIT MASONRY

DIVISION 05 — METALS

051200 STRUCTURAL STEEL FRAMING
054000 COLD-FORMED METAL FRAMING
055000 METAL FABRICATIONS

DIVISION 06 — WOOD, PLASTICS, AND COMPOSITES

061053 MISCELLANEOUS ROUGH CARPENTRY
064116 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS
066400 PLASTIC PANELING

DIVISION 07 — THERMAL AND MOISTURE PROTECTION

072100 THERMAL INSULATION
074213.13 FORMED METAL WALL PANELS
074213.19 INSULATED METAL WALL PANELS
076200 SHEET METAL FLASHING AND TRIM
077100 ROOF SPECIALTIES
077253 SNOW GUARDS
078413 PENETRATION FIRESTOPPING
078443 JOINT FIRESTOPPING
079200 JOINT SEALANTS
079219 ACOUSTICAL JOINT SEALANTS

DIVISION 08 — OPENINGS

081113 HOLLOW METAL DOORS AND FRAMES
081416 FLUSH WOOD DOORS
083113 ACCESS DOORS AND FRAMES
083800 TRAFFIC DOORS
084113 ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS
087100 DOOR HARDWARE
088000 GLAZING
088300 MIRRORS

DIVISION 09 — FINISHES

090561.13 MOISTURE VAPOR EMISSION CONTROL
092116.23 GYPSUM BOARD SHAFT WALL ASSEMBLIES
092216 NON-STRUCTURAL METAL FRAMING
092900 GYPSUM BOARD
093013 CERAMIC TILING
095113 ACOUSTICAL PANEL CEILINGS
096513 RESILIENT BASE AND ACCESSORIES
096516 RESILIENT SHEET FLOORING
096723 RESINOUS FLOORING
096813 TILE CARPETING
097200 WALL COVERINGS

098433 SOUND-ABSORBING WALL UNITS
098436 SOUND-ABSORBING CEILING UNITS
099113 EXTERIOR PAINTING
099123 INTERIOR PAINTING
099600 HIGH-PERFORMANCE COATINGS

DIVISION 10 — SPECIALTIES

102600 WALL AND DOOR PROTECTION
102800 TOILET, BATH, AND LAUNDRY ACCESSORIES
104116 EMERGENCY KEY CABINETS
104300 EMERGENCY AID SPECIALTIES
104413 FIRE PROTECTION CABINETS
104416 FIRE EXTINGUISHERS
107316.13 METAL PERGOLA

DIVISION 11 — EQUIPMENT

113013 RESIDENTIAL APPLIANCES
114000 FOOD SERVICE EQUIPMENT
118129 FACILITY FALL PROTECTION

DIVISION 12 — FURNISHINGS

122413 ROLLER WINDOW SHADES
123661.16 SOLID SURFACING COUNTERTOPS
123661.19 QUARTZ AGGLOMERATE COUNTERTOPS

DIVISION 13 — SPECIAL CONSTRUCTION

133419 METAL BUILDING SYSTEMS
133613 FABRICATED STORM SHELTERS

DIVISION 21 — FIRE SUPPRESSION

210500 COMMON WORK RESULTS FOR FIRE SUPPRESSION
210505 PROJECT CLOSEOUT FOR FIRE SUPPRESSION
211300 FIRE SUPPRESSION SPRINKLER SYSTEMS

DIVISION 22 — PLUMBING

220513 COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT
220517 SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING
220518 ESCUTCHEONS FOR PLUMBING PIPING
220519 METERS AND GAGES FOR PLUMBING PIPING
220523.12 BALL VALVES FOR PLUMBING PIPING
220523.14 CHECK VALVES FOR PLUMBING PIPING
220523.15 GATE VAVLES FOR PLUMBING PIPING
220529 HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
220548.13 VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT
220553 IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
220593 TESTING ADJUSTING AND BALANCING FOR PLUMBING
220719 PLUMBING PIPING INSULATION

220800 COMMISSIONING FOR PLUMBING
221116 DOMESTIC WATER PIPING
221119 DOMESTIC WATER PIPING SPECIALTIES
221123.21 INLINE DOMESTIC-WATER PUMPS
221316 SANITARY WASTE AND VENT PIPING
221319 SANITARY WASTE PIPING SPECIALTIES
221319.13 SANITARY DRAINS
221323 SANITARY WASTE INTERCEPTORS
223300 ELECTRIC DOMESTIC-WATER HEATERS
224213.13 COMMERCIAL WATER CLOSETS
224216.13 COMMERCIAL LAVATORIES
224216.16 COMMERCIAL SINKS
224223 COMMERCIAL SHOWERS
224713 DRINKING FOUNTAINS

DIVISION 23 — HEATING VENTILATING AND AIR CONDITIONING

230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
230517 SLEEVES AND SLEEVE SEALS FOR HVAC PIPING
230529 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
230548.13 VIBRATION CONTROLS FOR HVAC
230553 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
230593 TESTING ADJUSTING AND BALANCING FOR HVAC
230713 DUCT INSULATION
230719 HVAC PIPING INSULATION
230800 COMMISSIONING OF HVAC
230900 INSTRUMENTATION AND CONTROL FOR HVAC
232300 REFRIGERANT PIPING
233113 METAL DUCTS
233300 AIR DUCT ACCESSORIES
233346 FLEXIBLE DUCTS
233423 HVAC POWER VENTILATORS
233600 AIR TERMINAL UNITS
233713.13 AIR DIFFUSERS
233713.23 REGISTERS AND GRILLES
233723 HVAC GRAVITY VENTILATORS
237433 DEDICATED OUTDOOR-AIR UNITS
238126 SPLIT-SYSTEM AIR-CONDITIONERS
238129 VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS
238216.14 ELECTRIC-RESISTANCE AIR COILS
238239.19 WALL AND CEILING UNIT HEATERS

DIVISION 26 — ELECTRICAL

260500 COMMON WORK RESULTS FOR ELECTRICAL
260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
260526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
260529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
260533 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
260543 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS

260570 OVERCURRENT PROTECTIVE DEVICE STUDIES
260800 COMMISSIONING FOR ELECTRICAL
260923 LIGHTING CONTROL SYSTEMS AND DEVICES
261219 PAD-MOUNTED LIQUID-FILLED MEDIUM-VOLTAGE TRANSFORMERS
262213 LOW-VOLTAGE DISTRIBUTION TRANSFORMERS
262413 SWITCHBOARDS
262416 PANELBOARDS
262726 WIRING DEVICES
262813 FUSES
262816 DISCONNECT SWITCHES
262818 CIRCUIT BREAKERS
265100 LIGHTING

DIVISION 27 — COMMUNICATIONS

270526 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS
270528 PATHWAYS FOR COMMUNICATIONS SYSTEMS
270532 COMMUNICATIONS EQUIPMENT AND CABLING SYSTEMS
270536 CABLE TRAYS FOR COMMUNICATIONS SYTEMS
270544 SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING
270553 LABELS FOR COMMUNICATIONS SYSTEMS
271619 COMMUNICATIONS PATCH CORDS
272133 DATA COMMUNICATIONS WIRELESS ACCESS POINTS

DIVISION 28 — ELECTRONIC SAFETY AND SECURITY

280800 COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS
281300 SECURITY SYSTEMS UPDATED 08162023
283105 FIRE ALARM CABLES AND PATHWAYS
283111 DIGITAL ADDRESSABLE FIRE-ALARM SYSTEM
283131 PROPRIETARY SUPERVISING STATION FIRE-ALARM AND EMERGENCY COMMUNICATION SYSTEM

DIVISION 32 — EXTERIOR IMPROVEMENTS

323119 METAL GATES

END OF SECTION 000110

SECTION 003132 - GEOTECHNICAL DATA

1.1 GEOTECHNICAL DATA

A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information. This Document and its attachments are not part of the Contract Documents.

B. Because subsurface conditions indicated by the soil borings are a sampling in relation to the entire construction area, and for other reasons, the Owner, the Architect, the Architect's consultants, and the firm reporting the subsurface conditions do not warranty the conditions below the depths of the borings or that the strata logged from the borings are necessarily typical of the entire site. Any party using the information described in the soil borings and geotechnical report shall accept full responsibility for its use.

C. A geotechnical investigation report for Project, prepared by Terracon, dated September 15, 2025, is available for viewing as appended to this Document.

1. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.
2. Any party using information described in the geotechnical report shall make additional test borings and conduct other exploratory operations that may be required to determine the character of subsurface materials that may be encountered.

END OF SECTION 003132

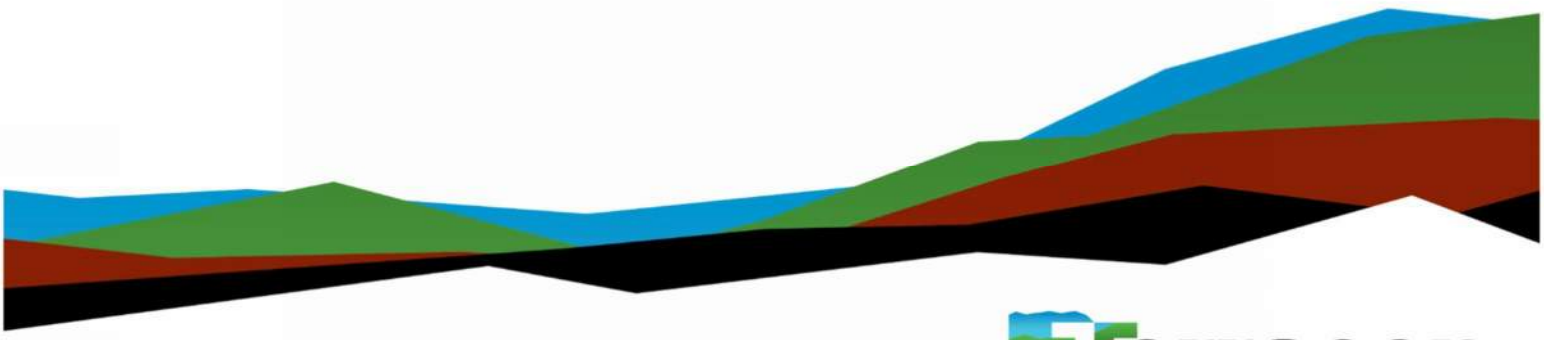
Project Clydesdale Design Level Geotech

Design Level Geotechnical Engineering Report

September 15, 2025 | Terracon Project No. 04255087

Prepared for:

Kimley-Horn & Associates Inc.
1437 S Boulder Ave
Tulsa, Oklahoma 74119



Terracon
Explore with us

Nationwide
Terracon.com

- Facilities
- Environmental
- Geotechnical
- Materials

9522 East 47th Place, Unit D
Tulsa, Oklahoma 74145
P (918) 250-0461
Terracon.com

September 15, 2025

Kimley-Horn & Associates Inc.
1437 S Boulder Ave
Tulsa, Oklahoma 74119

Attn: Randall, Devin
P: (918) 440-1553
E: Devin.Randall@kimley-horn.com

Re: Design Level Geotechnical Engineering Report
Project Clydesdale Design Level Geotech
E 76th Street N
Owasso, Oklahoma
Terracon Project No. 04255087

Dear Mr. Randall:

We have completed the scope of Design Level Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. P04255087 dated May 19, 2025. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon
Certificate of Authorization #CA-4531, Expires 6/30/2027

Aaron M. Baker, E.I.
Field Engineer

Kole C. Berg, P.E. (KS)
Senior Engineering Consultant

Ripken B. Dodson, P.E.
Oklahoma No. 36011

Table of Contents

Introduction **1**
Project Description **1**
Site Conditions **6**
Geotechnical Characterization **7**
Laboratory Thermal Resistivity 8
Laboratory Corrosion Testing 9
Seismic Site Class **10**
Geotechnical Overview **11**
Earthwork **12**
Site Preparation 13
Excavation 13
Rippability 14
Fill Induced Settlement Considerations 16
Soil Stabilization 17
Fill Material Types 19
Fill Placement and Compaction Requirements 21
Utility Trench Backfill 22
Grading and Drainage 23
Earthwork Construction Considerations 24
Construction Observation and Testing 25
Data Center Building Foundations **25**
Shallow Foundation Design Recommendations – Western Portions of DC1A and DC2A, Northern Portion of DC3A 26
Shallow Foundation Construction Considerations – Western Portions of DC1A and DC2A, Northern Portion of DC3A 26
Drilled Pier Axial Design Recommendations – Central and Eastern Portions of DC1A and DC2A, Southern Portion of DC3A 27
Drilled Pier Lateral Design Recommendations – Central and Eastern Portions of DC1A and DC2A 28
Drilled Pier Lateral Design Recommendations – Southern Portion of DC3A 29
Drilled Pier Lateral Loading Grouping – Central and Eastern Portions of DC1A and DC2A, Southern Portion of DC3A 29
Drilled Pier Construction Considerations – Central and Eastern Portions of DC1A and DC2A, Southern Portion of DC3A 30
Switching Station and Substation Foundations **31**
Shallow Foundation Design Recommendations – Equipment Pads 32
Shallow Foundation Construction Considerations – Small Equipment Pads 32
Mat Foundation Design Recommendations – Transformer Pads 34
Mat Foundation Construction Considerations – Transformer Pads 34
Driller Pier Design Recommendations – All Substation and Switching Station Structures 35

HUB and Access Building Foundations 36
Shallow Foundation Design Parameters 36
Floor Slabs 37
Floor Slab Design Parameters 37
Floor Slab Construction Considerations 38
Lateral Earth Pressures 39
Lateral Earth Pressure Design Parameters 39
Subsurface Drainage for Below-Grade Walls 40
Pavements 41
General Pavement Comments 41
Pavement Design Parameters 41
Pavement Section Thicknesses 42
General Comments 43

Attachments

Exploration and Testing Procedures
Site Location and Exploration Plans
Exploration and Laboratory Results
Subsurface Profile Fences
Rock Core Photography Logs
Supporting Information

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Design Level Geotechnical Engineering services performed for the proposed data center buildings to be located off E 76th Street N in Owasso, Oklahoma. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil and rock conditions
- Groundwater conditions
- Seismic site classification per IBC
- Site preparation and earthwork
- Foundations
- Floor slabs
- Lateral earth pressure parameters
- Pavements

The geotechnical engineering Scope of Services for this project included the advancement of test borings, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs in the **Exploration Results** section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Our understanding of the project is from conversations and email correspondence with the Client and the following provided documents: ■ Prelim Mass Grading Exhibit – 20250418, dated 4/18/25 ■ 20250428-CLY Test Fit, dated 4/25/25

Item	Description
Project Description	According to the Test Fit dated April 25, 2025, and a preliminary mass grading exhibit prepared by Kimley-Horn, we understand that the project will include: ■ 3 data center buildings (labeled DC1A through DC3A) with footprints ranging between 890,000 and 1,200,000 square feet (sf) ■ 1 switching station with an area of about 400,000 sf ■ 1 temporary substation with an area of about 60,000 sf ■ 4 stormwater detention ponds with total areas ranging between 1.94 and 4.98 acres. We assume the ponds will have slopes of 3H:1V or flatter. ■ 2 HUB buildings with footprints of 24,000 and 35,000 sf, respectively ■ 1 access drive building ■ Associated surface pavements/drive isles
Finished Floor Elevation	Based on the mass grading plan provided, we have considered the following FFEs for each building: ■ DC1A: 640’ ■ DC2A: 662’ ■ DC3A: 649’ – 655’ ■ HUB building (Phase 1): 657.5’ ■ HUB building (Phase 3): 677’ – 683’ ■ Access drive building: 663’
Maximum Loads	Anticipated maximum structural loads were provided in “Geotechnical Engineering Design Standard (North America) – v.1 – 2024-03-11” for the data center buildings and HUB buildings. <u>Data Center Buildings:</u> ■ Column Loads: 500 kips ■ Floor Slab Load: 350 pounds per square foot (psf) ■ Wall Loads: 12.5 kips per linear foot (klf) <u>HUB and Access Drive Buildings:</u> ■ Column Loads: 200 kips ■ Floor Slab Load: 120 psf ■ Wall Loads: 3 klf

Item	Description
	Anticipated maximum loads for substation structures were not provided. We estimated the following maximum structural loads based on previous similar projects: <u>Substation and Switching Station:</u> Bus and Switch Supports ■ Axial: 1 – 6 kips ■ Shear: 1 – 6 kips ■ Moment: 10 – 120 kip-ft Small Equipment Pads: ■ Axial: 5 – 25 kips Dead End Structures: ■ Axial: 50 – 200 kips ■ Shear: 10 – 30 kips ■ Moment: 200 – 600 kip-ft Control House and Transformers: ■ Axial: 50 – 400 kips We request that the design team review these estimated loads and provide us with updated loading information when it becomes available. Revisions to our recommendations may be necessary if loads will be significantly different than these assumptions.

Item	Description
Grading/Slopes	Based on the preliminary site grading plan provided by Kimley-Horn, we anticipate the following cuts and fills for each pad: DC1A ■ Maximum Cut Depth: 16’ ■ Maximum Fill Thickness: 16’ DC2A ■ Maximum Cut Depth: 30’ ■ Maximum Fill Thickness: 24’ DC3A ■ Maximum Cut Depth: 30’ ■ Maximum Fill Thickness: 16’ North HUB Building ■ Maximum Cut Depth: 33’ ■ Maximum Fill Thickness: 0’ South HUB Building ■ Maximum Cut Depth: 24’ ■ Maximum Fill Thickness: 0’ Access Drive Building ■ Maximum Cut Depth: 16’ ■ Maximum Fill Thickness: 0’ Switching Station ■ Maximum Cut Depth: 8’ ■ Maximum Fill Thickness: 30’ We understand that a final site grading plan will be completed after submittal of this report. We plan to update the cut depths and fill thicknesses on this table, along with the recommendations presented in this report, when final plans are provided for our review.
Below-Grade Structures	We anticipate some loading dock walls with a height on the order of 4 feet will be planned.

Item	Description
Retaining Walls	We understand that two retaining walls are planned at the site, both within the Phase 2 area. The first retaining wall, planned near the northeast corner of the DC2A building pad, is anticipated to be a maximum of 27 feet tall. The second retaining wall, planned near the southwest corner of the DC2A building pad, is anticipated to be a maximum of 18 feet tall. We further understand that the wall type(s) have not yet been determined. However we understand the walls may be mechanically stabilized earth (MSE) walls. Terracon's scope of services does not include engineering analyses (internal stability, external stability, or global) stability, design, or preparation of plans/specifications for MSE retaining walls. We understand the client may retain Terracon to perform global stability analyses of the MSE walls at a later time for an additional fee. These analyses (if authorized by the client) will be performed after submittal of this report and submitted as a separate document.

Item	Description
Pavements	From section 30.1 of the "Geotechnical Engineering Design Standard (North America) – v.1 – 2024-03-11", ADT is based off maximum operating capacity of the facility. The maximum operating capacity of each building (DC1A through DC3A, provided by Kimley-Horn) is 200 MW, which correlates to an ADT of 1,000 vehicles/day for each building. Through discussion with Kimley-Horn, we also understand that a main spine road through the campus is planned that will receive traffic from all three buildings. We have designed this road for a capacity of 600 MW which correlates with an ADT of 2,670 vehicles/day. A breakdown of the anticipated vehicle types and descriptions is shown below: ▪ Class 2/3, 2-Axle 4-Tire: 95% ▪ Class 6, 3-Axle Single Unit: 4% ▪ Class 9, 5-Axle Tractor Semitrailer: 1% The pavement design periods are 20 years for asphalt and 35 years for concrete.

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration.

Item	Description
Parcel Information	The project is located between 76th and 86th Street North and between Yale Avenue and Sheridan Road in Tulsa County, Oklahoma. Latitude/Longitude (approximate): 36.2125, -95.3037 See **Site Location**

Item	Description
Existing Improvements	Undeveloped parcel. Ground cover consists of grass, dense brush, and dense trees.
Existing Topography	Based on topographical information available, the site has a gradual downward slope from west to east. Total elevation change across the site is approximately 100 feet.

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** and the GeoModel can be found in the **Figures** attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Native Soils**	Lean clay, shaley lean clay, clayey sand, fat clay, shaley fat clay, silt, silty sand, sandy silt; varying shades of brown, gray, and red in color; very soft to hard; loose to dense
2	**Bedrock**	Sandstone: Highly weathered to slightly weathered; poorly cemented to well cemented Shale: Highly weathered to slightly weathered; soft to hard

The borings were advanced using hollow stem augers that allow for short term groundwater observations to be made while drilling. Groundwater was encountered in the following borings at the following depths/elevations (values in the table are rounded to the nearest ½ foot):

Boring ID	Shallowest Depth at Which Groundwater Was Encountered (feet) / Elevation
B-102	3.5 / 687.5
B-166	8.0 / 683.0
B-168	5.0 / 658.0
B-173	5.0 / 644.0
B-174	3.5 / 655.5
B-176	4.0 / 687.0
B-182	3.5 / 694.5
B-185	13.5 / 686.7
B-188	18.5 / 676.5
B-191	15.0 / 685.0
B-195	10.0 / 639.0
B-199	10.0 / 633.0
B-203	10.0 / 616.0
B-207	10.0 / 632.0
B-213	0.5 / 626.5
B-227	18.5 / 639.5

Groundwater conditions may change because of seasonal variations in rainfall, runoff, alterations to the site due to construction, and other conditions not apparent at the time of drilling. Therefore, groundwater conditions at other times may be different from the conditions encountered in our exploratory borings. The potential for water level fluctuations and perched water should be considered when developing design and construction plans and specifications for the project. Long-term groundwater monitoring was outside the scope of services for this project.

Laboratory Thermal Resistivity

Laboratory thermal resistivity testing was performed by Terracon on portions of selected bulk samples and thin-walled tube samples obtained during our exploration. The thermal resistivity testing was performed in general accordance with the IEEE standard. The dry-out curves for the bulk samples were developed from soils specimens compacted to approximately 90% of the standard Proctor maximum dry density (ASTM D698) at the standard Proctor optimum moisture content for recompacted bulk samples and at the in-situ density and moisture content for thin-walled tube samples. Samples were dried to 0% moisture to develop dry-out curves. The individual laboratory thermal resistivity dry-out curves are provided in the **Laboratory Test Results** section of this report and are summarized below.

Test Condition	Thermal Resistivity (°C-cm/W) [1, 2]				Number of Tests
	Parameter	Min.	Max.	Average	
Recompacted Bulk Samples					
90% Compaction	Wet	56	77	67	2
	Dry	107	128	118	
Shelby Tube Samples					
In-Situ	Wet	54	64	59	2
	Dry	97	144	121	

1. The "Dry" samples were tested at a moisture content of 0%.
2. The "Remolded Wet" samples were tested near the optimum moisture content for bulk samples and near the in-situ moisture content for tube samples.

Laboratory Corrosion Testing

The table below summarizes the results of laboratory pH, soluble sulfate, sulfides, soluble chloride, total salts, oxidation reduction potential (redox), and electrical resistivity testing performed on selected samples. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction. The actual test data from each sample is provided in the **Exploration Results** section.

Corrosivity Test Results Summary

Parameter	Number of Tests	Minimum	Maximum	Average
pH	9	5.4	8.9	7.3
Soluble Sulfate (mg/kg)	9	115	881	378
Sulfides (mg/kg)	9	Nil	Nil	Nil
Soluble Chloride (mg/kg)	9	24	185	75

Corrosivity Test Results Summary

Parameter	Number of Tests	Minimum	Maximum	Average
Redox (mV)	9	129	337	224
Total Dissolved Salts (mg/Kg)	9	107	1,460	577
Electrical Resistivity (Ω-cm)	9	1,100	16,000	4,322

Numerous sources are available to characterize corrosion potential to buried metals using the parameters above. Section 24 of the "Geotechnical Engineering Design Standard (North America) – v.1 – 2024-03-11" states the following soil or site conditions should be considered as indicative of potential deterioration or corrosion for steel:

- Soil Resistivity (Ω-cm)
  - 10,000 to 20,000: Mildly Corrosive
  - 5,000 to 10,000: Moderately Corrosive
  - 3,000 to 5,000: Corrosive
  - 1,000 to 3,000: Highly Corrosive
  - <1,000: Extremely Corrosive
- pH less than 4 or greater than 10
- Sulfates or chloride concentration greater than 500 ppm (mg/kg)

Based on the corrosivity testing results, the site conditions may be considered medium to high for potential corrosion of buried steel elements. Portions of the site that are unexplored may exhibit higher corrosive properties. These test results are provided to assist in determining the type and degree of corrosion protection that may be required. We recommend a NACE certified corrosion professional be retained to analyze the need for corrosion protection and to design appropriate protective measures, if required.

Imported fill materials may have significantly different properties than the site materials noted above and should be evaluated if expected to be in contact with concrete and/or metals used for construction.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard

penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the subsurface conditions encountered at the site, **Seismic Site Classification of C** can be considered for the project. Subsurface explorations at this site were extended to a maximum depth of 40 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

Recommended seismic design values are included in the following table.

Parameter	Design Value
PGA (g)	0.078
S_S (g)	0.17
S_1 (g)	0.08
S_{MS} (g)	0.18
S_{M1} (g)	0.11
F_{pga}	1.2
F_a	1.2
F_v	1.6
A_s (g)	0.075
S_{DS} (g)	0.12
S_{D1} (g)	0.073
Seismic Zone	1
Seismic Design Category	B

Geotechnical Overview

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test borings, provided that the recommendations provided in this report are implemented in the design and construction phases of this project.

Based on the conditions encountered and estimated load-settlement relationships, the proposed data center buildings can be supported on a combination of shallow footings and drilled piers, with both foundation types bearing in the bedrock (shale and/or sandstone) encountered at the site. To reduce the potential for excessive differential

settlement, foundations for the data center buildings should bear only on shale or sandstone bedrock (not on native soil or newly placed fill). The access drive building and HUB buildings may be supported on conventional continuous or spread footings bearing in the native lean clay or clayey sand soil, or in shale or sandstone bedrock. Within the switching station and temporary substation, small equipment pads can be supported on shallow footings bearing in either native soils, shale bedrock, or sandstone bedrock. Transformers may be supported on mat foundations bearing in native soils, shale bedrock, or sandstone bedrock. Small equipment, bus/switch supports, dead end structures, control houses, transmission poles, and transformers may all be supported on drilled piers bearing in the shale or sandstone bedrock.

Based on the grading plan provided and conversations with the client, we understand cuts of up to 25 feet and fills of up to 30 feet will be required to construct the building pad and pavements. Cuts will extend into shale and sandstone bedrock, refer to the **Excavation** section below for additional details. Based on our analysis, the native soils that overly bedrock have the potential to consolidate on the order of 2 to 4 inches for phase 1 of the project and on the order of 1 to 3 inches for phases 2 and 3, under the weight of the new fill. In addition, the fill induced settlement is not anticipated to be uniform as the depth of fill across the site is not uniform. In our opinion, the new fill required to develop the site should be placed as early in the construction schedule as possible and the settlement should be monitored as described in the **Fill Induced Settlement Considerations** section. After the existing soils have consolidated sufficiently, construction of foundations, floor slabs, pavements, and other settlement sensitive improvements can proceed in the normal manner.

We understand that, in lieu of importing suitable lower plasticity cohesive materials, the use of limestone screenings as low plasticity fill below the building floor slabs has been suggested. Although limestone screenings would meet the criteria of a low-volume-change material, we do not recommend the use of this material as low plasticity fill below the building floor slabs. This material often becomes very soft and unstable when saturated and can be easily disturbed by construction traffic.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include clearing and grubbing, excavations, and engineered fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality

criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Site Preparation

Prior to placing fill, existing vegetation, topsoil, root mats, and any loose, soft, or otherwise unsuitable soils should be removed. Complete stripping of the topsoil should be performed in the proposed building and parking/driveway areas. Organic soils removed during site preparation should not be used as fill beneath the proposed new building and pavement areas.

Mature trees are located within or near the footprint of some of the proposed buildings, which will require removal at the onset of construction. Tree root systems can remove substantial moisture from surrounding soils. Where trees are removed, the full root ball and all associated dry and desiccated soils should be removed. The soil materials which contain less than 5 percent organics can be reused as engineered fill provided the material is moisture conditioned and properly compacted.

The subgrade should be proofrolled with an adequately loaded vehicle such as a fully-loaded tandem-axle dump truck. The proofrolling should be observed by a representative of the Geotechnical Engineer. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should be improved by scarification/compaction or by removal and replacement with engineered fill. Excessively wet or dry material should either be removed or moisture conditioned and recompacted.

Where fill is placed on existing slopes steeper than 5H:1V, benches should be cut into the existing slopes prior to fill placement. The benches should have a minimum vertical face height of 1 foot and a maximum vertical face height of 3 feet and should be cut wide enough to accommodate the compaction equipment. This benching will help provide a positive bond between the fill and natural soils and reduce the possibility of failure along the fill/natural soil interface.

Although no evidence of fill or underground facilities (such as septic tanks, cesspools, basements, and utilities) was observed during the exploration and site reconnaissance, such features could be encountered during construction. If unexpected fills or underground facilities are encountered, such features should be removed, and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Excavation

We anticipate that shallow excavations made in native soils or new engineered fill for the proposed construction can be accomplished with conventional earthmoving equipment.

The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

Shale and sandstone bedrock will be encountered in excavations, especially where large excavations occur to accommodate grading. Our opinion on the rippability of shale and sandstone bedrock anticipated to be encountered during site grading is enclosed in our rippability memo dated June 12th, 2025, and is included below in the **Rippability** section of this report. Excavation of harder bedrock (i.e., shale or sandstone bedrock with SPT blow counts greater than 50 for 12 inches of sampler penetration, and/or with shear wave velocities over 8,500 ft/s) will likely require the use of jackhammers, rock splitters, pneumatic breakers, or blasting. Excavation of rock in confined areas (such as trenches) is usually difficult, even above the level of auger refusal.

For the materials anticipated to be encountered in excavations, we recommend the following bulking/shrinkage factors for use in estimating excavation quantities. These values are provided relative to the in-situ (bank) density of the native soils.

On-Site Material	Compacted vs. In Situ Density
Clay	-10%
Silt	-15%
Sand	-10%
Sandstone/Shale	+30 to 40%

Rippability

Terracon performed ten seismic refraction surveys at eight select locations throughout the site. The seismic refraction surveys were performed using the p-wave refraction method. At locations SR-1 and SR-3, two lines were run in the same area perpendicular to each other (north-south and east-west).

Ripper performance charts published in the Caterpillar Performance Handbook correlate seismic velocity values for various rock types with tractor size. Our bedrock rippability assessment was performed based on ripper performance charts published in the Caterpillar Performance Handbook (50th Edition, 2022). According to the Caterpillar Performance Handbook, sandstone and shale bedrock with seismic velocities of up to about 6,300 ft/s are generally expected to be rippable using a D8R/T or D9R/T dozer equipped with a multi shank or single shank ripper. The Caterpillar Performance Handbook indicates that sandstone and shale bedrock with seismic velocities of up to about 8,500 ft/s are generally expected to be marginally rippable.

ODOT 2019 Construction Specifications considers that material can be classified as rock and considered as rock excavation when the rock mass has a seismic velocity of 7,000 ft/s or greater or that the rock mass cannot be loosened or broken down by ripping with a bulldozer with a minimum net flywheel power rating of 303 hp.

A summary of the lines we tested and the approximate ranges of bedrock rippability based on seismic velocities at the mid-point of the line and the use of a D8R/T or D9R/T equipped with a multi shank or single shank ripper is provided in the following table. Please see the attached velocity models in **Exploration Results** with the approximate boundaries for more detail.

Line	Proposed Cut Areas	Closest Proximity Boring	Rippable[1]	Marginally Rippable[1,2]	ODOT Rock Excavation Threshold[1]
SR-1EW	Building 3 Area	B-228	10 to 15 feet BGS	25 to 30 feet BGS	15 to 20 feet BGS
SR-1NS	Building 3 Area	B-228	10 to 20 feet BGS	25 to 30 feet BGS	15 to 25 feet BGS
SR-2	Building 3 Area	B-126	15 to 20 feet BGS	20 to 30 feet BGS	15 to 25 feet BGS
SR-3EW	Building 2 Area	B-176	10 to 15 feet BGS	20 to 30 feet BGS	15 to 20 feet BGS
SR-3NS	Building 2 Area	B-176	15 to 20 feet BGS	30 to 35 feet BGS	20 to 25 feet BGS
SR-4	Building 1 Area	B-197	15 to 25 feet BGS	35 to 40 feet BGS	20 to 30 feet BGS
SR-5	Building 2 Area	B-35	5 to 15 feet BGS	25 to 30 feet BGS	15 to 20 feet BGS
SR-6	Building 1 Area	B-61	10 to 20 feet BGS	25 to 30 feet BGS	15 to 25 feet BGS
SR-7	Building 2 Area	B-55	20 to 30 feet BGS	30 to 40 feet BGS	25 to 35 feet BGS
SR-8	Building 1 Area	B-63	25 to 35 feet BGS	35 to 45 feet BGS	30 to 35 feet BGS

1. Rippability estimates in the table are measured at the center of the array, please see Attachments P-Wave Velocity Profiles for full details
2. Rock beneath this threshold may not be rippable

The bedrock rippability assessment in the previous table, which is based on shear wave velocity, was performed based on ripper performance charts published in the Caterpillar Performance Handbook (50th Edition, 2022). It must be realized that these are indicators only. The contractor bidding and performing the earthwork at this site should evaluate and determine for themselves the actual rippability of the rock and the excavation methods that will be required for this project.

Previous experience on projects in Oklahoma using shear wave velocity as a guide to rippability of rock formations has proven reliable to our knowledge. However, a more conservative approach to establishing the depth to rippable rock might utilize engineering judgement based on a combination of seismic shear wave velocities, core log analysis and previous experience in the same or similar formation.

The rock formation is dependent upon a number of variables related to the rock mass including, but not limited to, discontinuity (joints/fractures/bedding) spacing and orientation, rock strength, angle of the equipment relative to the orientation of discontinuities, etc. Favorable conditions for rippability include frequent planes of weakness or discontinuities such as joints, fractures or laminations, weathering, moisture content, stratification, brittleness, and "lower" shear strength. Unfavorable conditions for rippability include massive rock with fewer planes of weakness, crystalline rocks, non-brittle energy-absorbing rock matrix, and "higher" shear strength. Other variables relative to rippability include the size of the equipment used, the skill of the operator, inclusions or "hard spots" in the rock, the condition of the equipment used, and the orientation of any planes of weakness such as fractures or layer bedding.

The table below provides a guidance to the design engineer for elevations below:

Line	Proposed Cut Areas	Closest Proximity Boring	Approximate Hard Rock Excavation Elev. (feet) for Construction Earthwork Quantity Purposes [1]
SR-1EW	Building 3 Area	B-228	Below 687
SR-1NS	Building 3 Area	B-228	Below 690
SR-2	Building 3 Area	B-126	Below 670
SR-3EW	Building 2 Area	B-176	Below 693
SR-3NS	Building 2 Area	B-176	Below 690
SR-4	Building 1 Area	B-197	Below 685
SR-5	Building 2 Area	B-35	Below 690
SR-6	Building 1 Area	B-61	Below 685
SR-7	Building 2 Area	B-55	Below 625
SR-8	Building 1 Area	B-63	Below 640

1. According to the Caterpillar Performance Handbook, P-wave velocities of 3,000 ft/s or greater may be considered shale or sandstone bedrock

Fill Induced Settlement Considerations

As previously described, fill placement of up to 30 feet will cause stress increases extending into the underlying soils, which will consolidate and settle under the new loads. Our analysis indicates the planned new fill thicknesses could result in settlement on the order of 2 to 4 inches for phase 1 of the project, and 1 to 3 inches for phases 2

and 3. Settlement of this magnitude may result in adverse shallow foundation, floor slab, pavement, and utility performance.

We recommend completing the grading where deep fills are planned early in the construction process and delaying construction of foundations, floor slabs, pavements, and other settlement sensitive improvements until the rate of settlement decreases to acceptable levels as determined by settlement monitoring. Settlement monitoring should be performed using a minimum of four settlement monuments for each phase (twelve total) installed in the areas of deepest fill around the site. The monuments should be installed as recommended by a Terracon representative. A common method of constructing a settlement monument is to auger a borehole at least 2 feet deep into the final subgrade (i.e., after fill placement is complete), set an approximately 5-foot-long steel post or piece of rebar into the hole, and set the pole in-place by backfilling the hole around the post with concrete. Once installed in deep fill areas, settlement monuments should be measured to the nearest hundredth of a foot at least twice weekly, and settlement readings should be forwarded to Terracon for evaluation. Based on our analysis and experience, we would anticipate on the order of 15 to 30 days may be required to achieve the desired settlement. This estimated delay is based on the proposed construction, the soil conditions observed, and the test results performed. However, other factors not tested at the time of this exploration may alter the time for the settlement to occur, such as the effective drainage path and permeability of the native soils, which could shorten or extend the delay. After the existing soils have consolidated as determined by survey, construction of foundations, floor slabs, pavements, and other settlement sensitive improvements can proceed in the normal manner.

If planned fill thicknesses beneath the building pad are limited to 12 feet or less, the settlement period may be waived and construction of foundations, floor slabs, and pavements may be completed immediately after placement of fill.

In our experience, the typical methods to reduce the delay due to settlement from placement of new fill would include installation of wick drains, installation of a ground improvement system (aggregate piers, stone columns, or rigid inclusions), and/or placement of temporary additional surcharge fill above planned final grade. These methods are typically only implemented when excessive delays are likely (on the order of 90+ days). Since implementation of any of these methods would likely require 2 to 3 weeks to implement, it is our opinion that they may not be economical or meaningfully improve the construction timeline for this project.

Soil Stabilization

Due to the low strength soils encountered in some of our borings, soil stabilization may be needed in areas of the site. Methods of subgrade improvement, as described below, could include scarification, moisture conditioning and recompaction, removal of unstable

materials and replacement with granular fill (with or without geosynthetics), and chemical stabilization. The appropriate method of improvement, if required, would be dependent on factors such as schedule, weather, the size of area to be stabilized, and the nature of the instability. More detailed recommendations can be provided during construction as the need for subgrade stabilization occurs. Performing site grading operations during warm seasons and dry periods would help reduce the amount of subgrade stabilization required.

If the exposed subgrade is unstable during proofrolling operations, it could be stabilized using one of the methods outlined below.

- **Scarification and Recompaction** - It may be feasible to scarify, dry, and recompact the exposed soils. The success of this procedure would depend primarily upon favorable weather and sufficient time to dry the soils. Stable subgrades likely would not be achievable if the thickness of the unstable soil is greater than about 1 foot, if the unstable soil is at or near groundwater levels, or if construction is performed during a period of wet or cool weather when drying is difficult.
- **Crushed Stone** - The use of crushed stone or crushed gravel is a common procedure to improve subgrade stability. Typical undercut depths would be expected to range from about 12 to 24 inches below finished subgrade elevation. The use of high modulus geosynthetics (i.e., geotextile or geogrid) could also be considered after underground work such as utility construction is completed. Prior to placing the geosynthetics, we recommend that all below grade construction, such as utility line installation, be completed to avoid damaging the geosynthetic. Equipment should not be operated above the geosynthetic until one full lift of crushed stone fill is placed above it. The maximum particle size of granular material placed over a geosynthetic should not exceed 1½ inches.
- **Chemical Modification** - Incorporation of Portland cement could be considered for improving unstable soils. Chemical modification should be performed by a pre-qualified contractor having experience with successfully stabilizing subgrades in the project area on similar sized projects with similar soil conditions. The hazards of chemicals blowing across the site or onto adjacent property should also be considered. Additional testing would be needed to develop specific recommendations to improve subgrade stability by blending chemicals with the site soils. Additional testing could include, but not be limited to, determining the most suitable stabilizing agent, the optimum amounts required, and the presence and concentration of sulfates in the soil.

Further evaluation of the need and recommendations for subgrade stabilization can be provided during construction as the geotechnical conditions are exposed.

Fill Material Types

Fill required to achieve design grades below structures and pavements, or within constructed slopes, should be classified as engineered fill. All materials incorporated in engineered fill sections must be free of organic matter and debris. Fill materials should not be frozen and should not be placed on a frozen subgrade. A sample of each material type should be tested prior to being used on the site. Below are the material types that will be encountered and may be utilized as fill as well as placement and compaction recommendations for each material type.

Sandstone Fill is defined as durable sandstone (sandstone that does not break down with added moisture) fragments, compacted to produce inter-particle contact within the sandstone fragment matrix. The sandstone fill should contain a sufficient amount of smaller particle sizes to fill voids between fragments. The maximum particle size of rock fragments within sandstone fill shall be 2 feet in dimension.

Sandstone fill should be used in deeper fills (at least 5 feet below bottom-of-floor-slab level in building areas, and at least 2 feet below bottom-of-pavement section level in pavement areas). To the extent practical, sandstone fill should not be placed in areas where utility trenches will be excavated. Sandstone fill should be placed in loose lifts, equal to or less than the maximum particle size being placed (2 feet, maximum dimension). Placement and compaction should be closely monitored on a full-time basis by a representative of Terracon, since compaction control testing using moisture-density gauges does not produce consistent data on rock fills. Each lift of sandstone fill shall be proofrolled prior to placement of the next subsequent lift to verify that proper compaction has been achieved. The moisture content should be sufficient to achieve compaction without pumping when proofrolled.

Soil/Sandstone Mixture fill is defined as a mixture of durable sandstone, soil, and processed clay-like shale with at least 20% of the material finer than 1 inch, but no more than 80% finer than 1 inch. The maximum particle size of sandstone fragments in the mixture shall be 2 feet in dimension. The soil in the soil/sandstone mixture should not consist of topsoil and should contain no more than 10% organics.

Soil/Sandstone Mixtures should be used in deeper fills (as described above). Soil/Sandstone Mixtures should be placed in loose lifts, equal to or less than the maximum particle size being placed (2 feet, maximum dimension). Placement and compaction should be closely monitored on a full-time basis by a representative of Terracon, since compaction control testing using moisture-density gauges does not produce consistent data on mixed rock and soil fills. Each lift of soil/sandstone mixture fill shall be proofrolled prior to placement of the next subsequent lift to verify that proper compaction has been achieved. The moisture content should be sufficient to achieve compaction without pumping when proofrolled.

Shale Fill: Shale fill can be classified as clay-like shale or rock-like shale. Clay like shale is defined as having similar physical characteristics as a clay soil, in that it can be easily molded and reshaped by hand such as the shaley lean and fat clays encountered in our borings. Clay like shale that can be moisture conditioned and manipulated so that it has the consistency of a clay soil, it should be placed in a manner similar to clay soils.

Harder (rock-like) shale will need to be processed into a clay-like shale before it can be used as fill. Substantial pulverization and moisture conditioning will be required to process harder, rock-like shale into a clay-like shale. Processing of rock-like shale normally requires a number of passes by heavy, tracked construction equipment to break the shale down to a material having a maximum 6-inch particle size and containing sufficient fines to completely fill void spaces between the larger particles. A substantial amount of water must be incorporated into the rock-like shale during fill placement to aid in breaking down the shale into a clay-like consistency. Shale can be considered "clay-like" (and suitable for use as shale fill) once it has been processed to a maximum particle size of 6 inches with at least 90% of the material finer than 3 inches and moisture conditioned to a soil-like consistency.

Shale fill should be used in deeper fills (as described above). Shale fill should be placed in maximum 9-inch thick, loose lifts. Placement and compaction should be closely monitored on a full-time basis by a representative of Terracon, since compaction control testing using moisture-density gauges does not produce consistent data on shale fills. Shale fill should be compacted to at least 95% of the standard Proctor dry density or should pass a proofroll. The moisture content should be sufficient to achieve compaction without pumping when proofrolled.

Soil fill is defined as any non-organic material (i.e., less than 5% organic content) with at least 80% of the material finer than 1 inch. Soil is commonly used as fill in this locale, but not all soils are suitable. Our professional opinions concerning suitability of fill materials are presented in the following table.

Soil Type [1]	USCS Classification	Acceptable Location for Placement
Imported Low Volume Change Materials [2]	CL, SC, GC, GM LL ≤ 45 & PI ≤ 20	All locations and elevations, except where free draining material is required
On-Site Soils [2]	CL, SC, SM	All locations and elevation, except where free draining material is required

Soil Type [1]	USCS Classification	Acceptable Location for Placement
	CL-ML, CH, ML	Pavement areas and greater than 2 feet below the bottom of floor slabs
Granular [2,3]	GW/GM	Subbase beneath floor slabs and pavements

1. Structural and general fill should consist of approved materials free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.
2. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.
3. ODOT Class "A" aggregate base course or similar

We understand that, in lieu of importing suitable lower plasticity cohesive materials or stabilizing the on-site soils, the use of limestone screenings as low plasticity fill below the building floor slab has been suggested. Although limestone screenings would meet the criteria of a low-volume-change material, we do not recommend the use of this material as low plasticity fill below the building floor slab. This material often becomes very soft and unstable when saturated and can be disturbed by construction traffic.

However, if limestone screenings are used as fill beneath the building pad, we recommend that the exposed subgrade be evaluated immediately prior to placement of the granular leveling course and construction of the building floor slabs. The building subgrade should be proofrolled to assess its stability. Proofrolling should be accomplished using a fully loaded (minimum 25 ton), tandem-axle dump truck or similar equipment providing an equivalent subgrade loading. Soft or unstable areas identified by the proofrolling operation should be reworked prior to placement of the granular leveling course and construction of the floor slab. If suitable stability cannot be achieved by reworking unsuitable areas, we recommend that areas of soft, saturated limestone screenings be undercut and brought up to grade with suitable material.

Fill Placement and Compaction Requirements

Engineered fill should meet the following compaction requirements.

Item	Description
Maximum Lift Thickness	9 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum Compaction Requirements for Soil Fill [1,2]	**Fill placed within 5 feet of finished grade**: At least 95% of the standard Proctor maximum dry density **Fill placed deeper than 5 feet below finished grade**: At least 98% of the standard Proctor maximum dry density **ODOT Type "A" Aggregate Base Course**: At least 98% of the standard Proctor maximum dry density
Water Content Range [1]	**Cohesive**: ▪ Low Plasticity (PI ≤ 20): -2% to +2% of optimum ▪ Highly Plasticity (PI > 20): 0% to +4% of optimum **Granular**: Workable moisture content

1. Maximum density and optimum water content as determined by the standard Proctor test (ASTM D 698)
2. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254). Materials not amenable to density testing should be placed and compacted to a stable condition observed by the Geotechnical Engineer or representative.

Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with structural fill or bedding material in accordance with public works specifications for the utility be supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility. Trench excavation should not be conducted below a downward 1:1 projection from existing foundations without engineering review of shoring requirements and geotechnical observation during construction.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath slabs or footings, the backfill should satisfy the gradation and expansion index requirements of engineered fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

Undground utilities buried more than 24 inches below final grade are not expected to experience uplift/heave due to seasonal moisture fluctuations of on-site clay soils or newly placed clay fill. If the owner and/or designer are concerned about the effect of potential seasonal shrink-swell movements of clay soils on utilities buried shallower than 24 inches below final grade, utility trench bedding and backfill material meeting the LVC criteria discussed in the Fill Material Types section should be used to a depth of at least 2 feet below finished grade.

Utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill stated previously in this report.

Grading and Drainage

The site should be graded to provide effective drainage away from the building during and after construction, and these conditions should be maintained throughout the life of the structure. Accumulation of water adjacent to the structure could contribute to significant moisture increases in the subgrade soils and subsequent softening/settlement or expansion/heave, which could result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks.

After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically checked and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and limit surface water infiltration.

Planters located within 10 feet of the building should be self-contained to prevent water accessing the building subgrade soils. Trees or other vegetation whose root systems

have the ability to remove excessive moisture from the subgrade and foundation soils should not be planted next to structures. Trees and shrubbery should be kept away from the exterior edges of the foundation element a distance of least equal 1.5 times their expected mature height. Sprinkler mains and spray heads should be located a minimum of 5 feet away from the building lines. Roof runoff should be collected in drains or gutters. Roof drains and downspouts should be discharged onto pavements which slope away from the buildings or downspouts should be extended a minimum of 10 feet away from the structure.

Earthwork Construction Considerations

Care should be taken to avoid disturbance of prepared subgrades. Unstable subgrade conditions can develop during general construction operations, particularly if the soils are wetted or subjected to repetitive construction traffic. If unstable subgrade conditions develop, stabilization measures will need to be employed. Construction traffic over the completed subgrade should be avoided to the extent practical. If the subgrade becomes frozen, desiccated, saturated, or disturbed, the affected materials should be removed or these materials should be scarified, moisture conditioned, and compacted before floor slab construction.

Based on conditions encountered in the borings, significant seepage is generally not expected in excavations for this project (e.g., for foundation construction and utility installation). If seepage is encountered in excavations during construction, the contractor is responsible for designing, implementing, and maintaining appropriate dewatering methods to control seepage and facilitate construction. In our experience, dewatering of excavations in clay soils can typically be accomplished using sump pits and pumps. If seepage occurs where sand seams or sand layers are encountered in excavations, a more extensive dewatering system may be required.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local, state, and federal safety regulations. The contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, the owner, contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties. Under no circumstances should the information provided in this report be interpreted to mean that Terracon is responsible for construction site safety or the contractor’s activities. Construction site safety is the sole responsibility of the contractor who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

Construction Observation and Testing

The earthwork efforts should be observed by a representative of the Geotechnical Engineer. Observation should include documentation of adequate removal of surficial materials (vegetation, topsoil, root mats, etc.), as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer before placing additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. Where not specified by local ordinance, one density and water content test should be performed for every 100 linear feet of compacted utility trench backfill and at least one test performed for every 12 vertical inches of compacted backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should be contacted to discuss mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Data Center Building Foundations

In our opinion, a combination of bedrock-bearing spread footings and bedrock-bearing drilled piers can be used to support the proposed data center buildings. To reduce the potential for differential movements between foundations supported on dissimilar bearing materials, in our opinion, irrespective of foundation type, all foundations should bear on bedrock consisting of competent shale and/or sandstone. Footings for the data center buildings should not be founded on native soils or on new fill. Where shale or sandstone is encountered at relatively shallow depths (i.e., less than about 5 feet below planned final grade), footings could bear directly on the shale or sandstone bedrock. Where shale or sandstone bedrock is encountered at greater depths, drilled pier foundations (also referred to as drilled shafts) can be used to support individual columns and a driller pier/grade beam system can be used to support walls. Design recommendations for shallow and deep foundations to support the proposed building are presented below.

Shallow Foundation Design Recommendations – Western Portions of DC1A and DC2A, Northern Portion of DC3A

Item	Description
Maximum Net Allowable Bearing Pressure [1, 2]	5,000 psf for footings bearing on suitable shale or sandstone bedrock
Minimum Foundation Dimensions	Isolated footings: 30 inches Continuous footings: 18 inches
Minimum Embedment below Finished Grade [3]	24 inches
Estimated Total Settlement from Structural Loads [4]	About ½ inch
Estimated Differential Settlement [4]	About 1/3 to 2/3 of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. This pressure assumes that any lower strength soils or other unsuitable materials, if encountered, will be undercut to the top of suitable shale or sandstone bedrock. Foundation concrete could extend to the suitable bedrock, or lean concrete could be placed in the over-excavation to re-establish design foundation bearing elevations.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical evaluation and consultation will be necessary if higher loads are anticipated.
3. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
4. Foundation settlement will depend upon the variations within the subsurface profile, the structural loading conditions, the embedment depth of footings, and the quality of the earthwork operations and footing construction. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 ft.

Shallow Foundation Construction Considerations – Western Portions of DC1A and DC2A, Northern Portion of DC3A

The rock at the base of each footing excavation should be observed and tested by Terracon. The excavation should be probed or otherwise sampled at each isolated spread footing and at regular intervals along continuous footings. The base of all foundation excavations should be free of water and loose rock or soil-like materials before placing reinforcing steel and concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. If bearing materials become disturbed, the affected material should be removed before placing concrete. If the excavations must

remain open for an extended period of time, placement of a lean concrete mud mat over the bearing surface should be considered.

Footings should bear directly on tested and approved bedrock or on lean concrete that extends to approved bedrock materials. If soils or other unsuitable materials are encountered at design foundation bearing depth, the footing excavations should be deepened to suitable bedrock bearing materials.

Drilled Pier Axial Design Recommendations – Central and Eastern Portions of DC1A and DC2A, Southern Portion of DC3A

Item	Description
Bearing Material	Competent shale or sandstone bedrock
Minimum Embedment	2 feet into competent bedrock
Net Allowable Bearing Pressure [1]	20,000 psf
Maximum Allowable Skin Friction [2]	2,500 psf
Minimum Shaft Diameter [3]	24 inches
Minimum Grade Beam Embedment Depth Below Finished Grade	24 inches
Estimated Total Settlement	About ½ inch
Estimated Differential Settlement	Less than about 2/3 of total settlement
Coefficient of Friction between Fill/Native Soil and Drilled Pier [4]	0.3

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the drilled pier base elevation. This pressure assumes that the piers will be founded in suitable shale or sandstone bedrock and have a length to diameter ratio (L/D) of at least 3.
2. Use skin friction for the portion of the drilled pier that penetrates at least two feet into competent shale or sandstone bedrock.
3. Assuming that enough steel reinforcement is used to provide adequate structural integrity.
4. Value provided for evaluation of drag load in deeper fill areas (in case the recommended settlement delay time is not implemented). Further discussion is provided in the following paragraph.

The following parameters do not consider drag load created by the downward skin friction of soils settling in deeper fill areas (fill areas over 12 feet) due to our recommendations regarding settlement of new fill. If fill is placed, compacted, and allowed to settle as recommended in **Fill Placement and Compaction Requirements** and **Fill Induced Settlement Considerations**, drag load will not be imposed on the piers. If pier construction is started while new fill over 12 feet is still in the process of settling, drag load will need to be accounted for by the structural engineer when designing the piers to ensure that the piers' structural capacity can withstand the negative skin friction created by the settlement of new fill. A coefficient of friction value between soil (fill and native soils) and the drilled piers is provided in the preceding table.

Drilled Pier Lateral Design Recommendations – Central and Eastern Portions of DC1A and DC2A

The following table lists input values for use in LPILE analyses. Modern versions of LPILE provide estimated default values of k_h and E_{50} based on strength and are recommended for the project. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

Stratigraphy[1]		LPILE Soil Model	S_u (psf)[2]	γ' (pcf)[2]	ε_{50}	K (pci)	
Depth[3] (ft)	Material					Static	Cyclic
0 to 24	New Engineered Fill	Stiff Clay w/o Free Water	1,000	120	Use Default Value		
24 to 44	Native Lean Clay	Stiff Clay w/o Free Water	1,000	120	Use Default Value		
44 and below	Bedrock (Shale or Sandstone)	Weak Rock	500 psi [4]	145	N/A		

1. See Subsurface Profile in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   S_u: Undrained shear strength
   γ': Effective unit weight
3. Depth of stratigraphic layers is based on the maximum depth to bedrock seen in our borings in areas of the deepest fill beneath the building pad. Depth of layers may vary based on boring location. See boring logs and GeoModel for more detailed layer information at each location.

Stratigraphy[1]		LPILE Soil Model	S_u (psf)[2]	γ' (pcf)[2]	ε_{50}	K (pci)	
Depth[3] (ft)	Material					Static	Cyclic

4. Unconfined compressive strength (q_u) for weak rock (provided here in psi). For shale and sandstone bedrock, use initial modulus of rock mass (E_m) of 50,000 psi, RQD of 50%, and strain factor (k_{rm}) of 0.0005.

Drilled Pier Lateral Design Recommendations – Southern Portion of DC3A

Stratigraphy[1]		LPILE Soil Model	S_u (psf)[2]	γ' (pcf)[2]	ε_{50}	K (pci)	
Depth[3] (ft)	Material					Static	Cyclic
0 to 24	New Engineered Fill	Stiff Clay w/o Free Water	1,000	120	Use Default Value		
24 to 39	Native Lean Clay	Stiff Clay w/o Free Water	1,000	120	Use Default Value		
39 and below	Bedrock (Shale or Sandstone)	Weak Rock	500 psi [4]	145	N/A		

1. See Subsurface Profile in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   S_u: Undrained shear strength
   γ': Effective unit weight
3. Depth of stratigraphic layers is based on the maximum depth to bedrock seen in our borings in areas of the deepest fill beneath the building pad. Depth of layers may vary based on boring location. See boring logs and GeoModel for more detailed layer information at each location.
4. Unconfined compressive strength (q_u) for weak rock (provided here in psi). For shale and sandstone bedrock, use initial modulus of rock mass (E_m) of 50,000 psi, RQD of 50%, and strain factor (k_{rm}) of 0.0005.

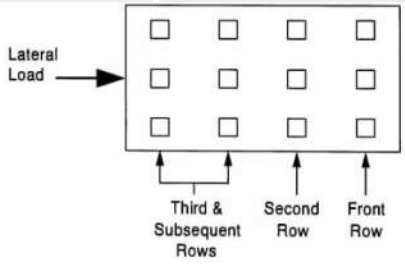
Drilled Pier Lateral Loading Grouping – Central and Eastern Portions of DC1A and DC2A, Southern Portion of DC3A

When drilled piers are used in groups, the lateral capacities of the piers in the second, third, and subsequent rows of the group should be reduced as compared to the capacity

of a single, independent pier. Guidance for applying p-multiplier factors to the p values in the p-y curves for each row of drilled pier foundations within a group are as follows:

Center to Center Drilled Pier Spacing [1,2]	P-Multiplier, P_m [3]		
	Front Row	Second Row	Third and Subsequent Rows
3B	0.8	0.4	0.3
4B	0.9	0.65	0.5
5B	1.0	0.85	0.7
6B	1.0	1.0	1.0

1. Spacing in the direction of loading. B = pier diameter
2. For the case of a single row of piles supporting a laterally loaded grade beam, group action for lateral resistance of drilled piers would need be considered when spacing is less than three pier diameters (measured center-to-center).
3. See adjacent figure for definition of front, second and third rows.



Spacing closer than 3D (where D is the diameter of the pier) is not recommended without additional geotechnical consultation due to potential for the installation of a new pier disturbing an adjacent installed pier likely resulting in axial capacity reduction.

Drilled Pier Construction Considerations – Central and Eastern Portions of DC1A and DC2A, Southern Portion of DC3A

The drilling contractor should be experienced in the subsurface conditions observed at the site, and the excavations should be performed with equipment capable of providing a clean bearing surface. The drilled pier foundation system should be installed in general accordance with the procedures presented in "Standard Specification for the Construction of Drilled Piers", ACI Publication No. 336.1-01.

The contractor is generally expected to use conventional "dry" techniques for installation of drilled piers. Groundwater was not encountered during the subsurface exploration in the borings. However, temporary casing or other specialized drilling techniques may be needed to advance the driller pier excavations and maintain stability of the sidewalls if groundwater conditions are different at the time of construction, or if/where pier excavations extend through cohesionless/granular soils or engineered fill consisting of cohesionless/granular soils or rock fill. We do not anticipate that personnel would need to enter the pier to clean and/or test the bearing surface; however, if this becomes

necessary, temporary casing would be required. The contractor would also need to check for gas and/or oxygen deficiency prior to anyone entering the excavation.

The bottom of pier excavations should be cleaned of any water and loose material before placing reinforcing steel and concrete. A minimum pier diameter of at least 30 inches is recommended for the project.

Concrete should be placed soon after excavating to minimize bearing surface disturbance. It is recommended the geotechnical engineer be retained to observe and test the foundation bearing materials. Any water accumulating in the pier excavation should be pumped from the excavation or the water should be allowed to stabilize and then concrete should be placed using the tremie method.

If concrete will be placed as the temporary casing is being removed, we recommend the concrete mixture be designed with an appropriate slump to reduce the potential for arching when removing the casing. While removing the casing from a pier excavation during concrete placement, the concrete inside the casing should be maintained at a sufficient level to resist any earth and hydrostatic pressures outside the casing during the entire casing removal procedure.

We recommend that a representative of Terracon be present during drilling activities to evaluate the materials removed from the drilled pier excavations to determine when adequate capacity has been developed, to observe the base of the drilled pier excavation to determine that the cuttings have been adequately removed, and also to observe the concrete placement methods.

Switching Station and Substation Foundations

Based on the conditions encountered and estimated load-settlement relationships, small equipment can be supported on shallow foundations bearing in native soil, engineered fill, shale bedrock, or sandstone bedrock or on drilled pier foundations bearing in shale or sandstone bedrock. Bus/switch supports, dead end structures, transmission pole structures, and control house structures can be supported on drilled shaft foundations bearing in shale or sandstone bedrock. Transformers may be supported using either a mat foundation or drilled piers bearing in shale or sandstone bedrock.

Shallow Foundation Design Recommendations – Equipment Pads

Item	Description
Maximum Net Allowable Bearing Pressure [1, 2, 3]	**Oversized footings bearing on native soils or engineered fill** [6]: 1,500 psf **Footings bearing on native soils or engineered fill:** 2,500 psf **Footings bearing on rock**: 5,000 psf
Minimum Foundation Dimensions	Isolated footings: 30 inches Continuous footings: 18 inches
Minimum Embedment below Finished Grade [4]	24 inches
Estimated Total Settlement from Structural Loads [2]	On the order of 1 inch
Estimated Differential Settlement [2, 5, 6]	About 1/2 to 2/3 of total settlement between foundations supported on soil. Up to 1 inch between soil- and rock-supported foundations.

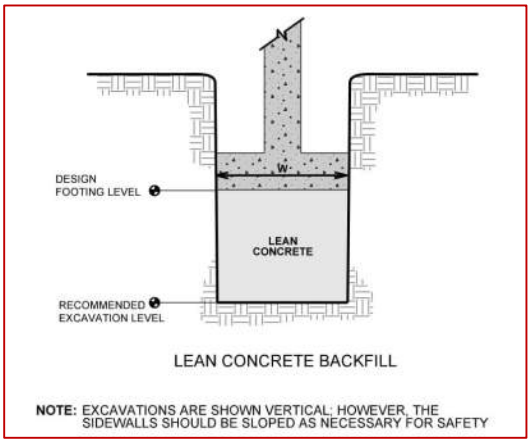
1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.
3. Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in **Earthwork**.
4. Embedment necessary to minimize the effects of frost and/or seasonal water content variations.
5. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.
6. Oversized footings could be considered to further decrease differential settlement to achieve an estimated ½ inch of differential settlement measured over a span of 20 feet.

Shallow Foundation Construction Considerations – Equipment Pads

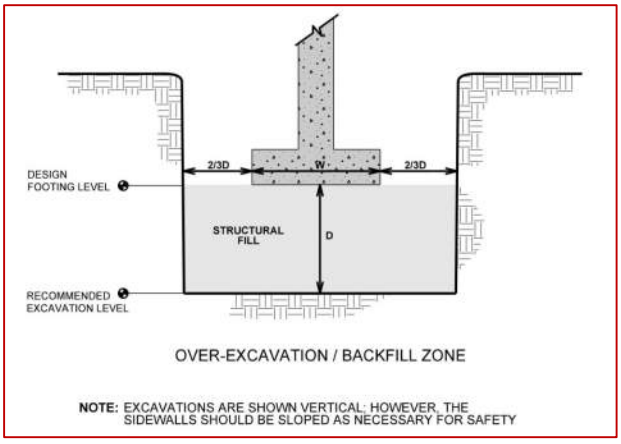
The base of all foundation excavations should be free of water and loose soil prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. If the soils at the bearing level become excessively dry, disturbed, saturated, or frozen, the affected soil should be removed prior to placing concrete. If the

excavations must remain open overnight or for an extended period of time, placement of a lean concrete mud-mat over the bearing soils should be considered.

The bearing materials at the base of each footing excavation should be evaluated by a representative of the Geotechnical Engineer. If unsuitable bearing materials are observed, the excavation should be extended deeper to suitable soils. The footings could bear directly on suitable soils at the lower level or on lean concrete backfill as shown on the following figure.



Soil-supported footings could also bear on properly compacted engineered fill extending down to suitable soils as shown in the following figure. Overexcavation for compacted engineered fill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below footing elevation. The overexcavation should then be backfilled up to the footing base elevation with well graded granular material (e.g., ODOT Type "A" aggregate or an approved alternate gradation) placed and compacted as recommended in the **Earthwork** section.



Mat Foundation Design Recommendations – Transformer Pads

Description	Value
Net Allowable Bearing Pressure [1]	**Mat bearing on native soils or engineered fill**: 1,500 psf **Mat bearing on rock:** 5,000 psf
Minimum Embedment Below Finished Grade for Frost Protection [2]	24 inches
Estimated Total Settlement from Structural Loads [3]	On the order of 1 inch
Estimated Differential Settlement	About 1/3 to 2/3 of total settlement
Coefficient of Sliding Friction [4]	0.3 (bearing on soil or fill) 0.45 (bearing on rock)

1. The allowable bearing pressure contains a factor of safety of at least 3 against general shear failure. The recommended net allowable bearing pressure is the pressure at the mat base elevation in excess of the minimum surrounding overburden pressure. All foundation excavations should be tested by a Terracon representative to verify that suitable bearing materials are encountered.
2. Minimum depth will provide frost protection. Greater foundation depth may be required to encounter the recommended bearing material.
3. Total settlement based on a mat foundation transmitting a pressure of 4,000 psf to the bearing soils.
4. Coefficient of friction value is an ultimate value and does not contain a factor of safety.

Mat Foundation Construction Considerations – Transformer Pads

We recommend the base of the mat excavation be observed and evaluated by the geotechnical engineer prior to placing reinforcing steel and concrete. If unsuitable soils or rock are encountered at the design bearing level, the mat should be extended deeper to encounter suitable soils or rock and the mat could bear directly on those soils or rock at the lower elevation or on lean concrete backfill placed in the excavation.

The mat excavation should be free of loose and disturbed material, debris, and water when concrete is placed. Concrete should be placed as soon as possible after the excavation is completed to reduce the potential for wetting, drying, or disturbance of the bearing materials.

Driller Pier Design Recommendations – All Substation and Switching Station Structures

Based on the subsurface conditions observed in the borings, small ancillary structures, bus and switch supports, dead end structures, transmission pole structures, control house structures, and transformer structures can all be supported by drilled piers bearing in shale or sandstone bedrock. Design soil parameters for drilled shaft foundations, representing the subsurface conditions observed at the borings, are presented on the **Drilled Concrete Pier Design Soil Parameters** tables included on the following pages. The values given in the tables are based on conditions observed in the borings, laboratory data, published values, and our experience. Note that these 4 pages of tables are not included in the page numbering system for this report, so they should be considered an extension of this page (page 35).

Drilled Concrete Pier Design Soil Parameters (Overburden) – Switching Station

Bottom Depth [1]	Layer Description	Total Unit Weight (pcf)	Undrained Shear Strength S_u (psf)	Internal Friction Angle Φ (degrees)	LPILE Parameters			MFAD Parameters
					LPILE Soil Model	ε_{50}	Static Soil Modulus Parameter K_s (pci)	Modulus of Deformation (ksi)
3.5	Overburden Soils	120	--	30	Sand (Reese)	Default		0.55

1. Approximate depth is below the existing ground surface. The stratigraphic layers shown above are based on our interpretation of soil strength and may not correspond with the descriptive classifications shown on the boring logs.

Lateral Drilled Concrete Pier Design Soil Parameters (Bedrock) – Switching Station

Bottom Depth [1]	Layer Description	Total Unit Weight (pcf)	LPILE Parameters[2]			MFAD Parameters[2]		
			Strain Factor (k rm)	Uniaxial compressive Strength (psi)	Initial Modulus of Rock Mass (psi)	Undrained Shear Strength S_u (ksf)	Internal Friction Angle Φ (degrees)	Modulus of Deformation (ksi)
20	Shale Bedrock	145	0.0005	500	50,000	2.1	30	250

1. Approximate depth is below the existing ground surface. The stratigraphic layers shown above are based on our interpretation of soil strength and may not correspond with the descriptive classifications shown on the boring logs.
2. Design capacities are dependent upon the method of installation, and quality control. The values provided are estimates and should be verified when installation protocol have been finalized. Shafts should extend at least one diameter into the bearing stratum for end bearing and lateral capacity within that layer to be considered for design.

Axial Drilled Concrete Pier Design Soil Parameters (Bedrock) – Switching Station

Bottom Depth [1]	Layer Description	Total Unit Weight (pcf)	Ultimate Skin Friction [2,3] (ksf)	Ultimate End Bearing [3] (ksf)
20	Shale Bedrock	145	2.5	20

1. Approximate depth is below the existing ground surface. The stratigraphic layers shown above are based on our interpretation of soil strength and may not correspond with the descriptive classifications shown on the boring logs.
2. Applicable for compressive loading only. Reduce to 2/3 of values shown for uplift loading.
3. Design capacities are dependent upon the method of installation, and quality control. The values provided are estimates and should be verified when installation protocol have been finalized. Shafts should extend at least one diameter into the bearing stratum for end bearing and lateral capacity within that layer to be considered.

Drilled Concrete Pier Design Soil Parameters (Overburden) – Temporary Substation

Bottom Depth [1]	Layer Description	Total Unit Weight (pcf)	Undrained Shear Strength S_u (psf)	Internal Friction Angle Φ (degrees)	LPILE Parameters			MFAD Parameters
					LPILE Soil Model	ε_{50}	Static Soil Modulus Parameter K_s (pci)	Modulus of Deformation (ksi)
8.5	Overburden Soils	120	1,500	--	Stiff Clay w/o Free Water	Default		0.55

1. Approximate depth is below the existing ground surface. The stratigraphic layers shown above are based on our interpretation of soil strength and may not correspond with the descriptive classifications shown on the boring logs.
2. Applicable for compressive loading only. Reduce to 2/3 of values shown for uplift loading.
3. NR = not recommended
4. Design capacities are dependent upon the method of installation, and quality control. The values provided are estimates and should be verified when installation protocol have been finalized. Shafts should extend at least one diameter into the bearing stratum for end bearing and lateral capacity within that layer to be considered for design.

Lateral Drilled Concrete Pier Design Soil Parameters (Bedrock) – Temporary Substation

Bottom Depth [1]	Layer Description	Total Unit Weight (pcf)	LPILE Parameters[2]			MFAD Parameters[2]		
			Strain Factor (k rm)	Uniaxial compressive Strength (psi)	Initial Modulus of Rock Mass (psi)	Undrained Shear Strength S_u (ksf)	Internal Friction Angle Φ (degrees)	Modulus of Deformation (ksi)
13.5	Shale Bedrock	145	0.0005	500	50,000	2.1	30	250
18.9	Sandstone Bedrock							

1. Approximate depth is below the existing ground surface. The stratigraphic layers shown above are based on our interpretation of soil strength and may not correspond with the descriptive classifications shown on the boring logs.
2. Design capacities are dependent upon the method of installation, and quality control. The values provided are estimates and should be verified when installation protocol have been finalized. Shafts should extend at least one diameter into the bearing stratum for end bearing and lateral capacity within that layer to be considered for design.

Axial Drilled Concrete Pier Design Soil Parameters (Bedrock) – Temporary Substation

Bottom Depth [1]	Layer Description	Total Unit Weight (pcf)	Ultimate Skin Friction [2,3] (ksf)	Ultimate End Bearing [3] (ksf)
13.5	Shale Bedrock	145	2.5	20
18.9	Sandstone Bedrock			

1. Approximate depth is below the existing ground surface. The stratigraphic layers shown above are based on our interpretation of soil strength and may not correspond with the descriptive classifications shown on the boring logs.
2. Applicable for compressive loading only. Reduce to 2/3 of values shown for uplift loading.
3. Design capacities are dependent upon the method of installation, and quality control. The values provided are estimates and should be verified when installation protocol have been finalized. Shafts should extend at least one diameter into the bearing stratum for end bearing and lateral capacity within that layer to be considered.

The drilled pier construction considerations section for the **Central and Eastern Portions of DC1A and DC2A, Southern Portion of DC3A** are applicable to the drilled piers for the switching and substation structures.

HUB and Access Building Foundations

Based on the conditions encountered at the borings, the buildings can be supported on shallow isolated and/or continuous foundations that bear on native clay or clayey sand soils, native shale or sandstone bedrock, and/or engineered fill, provided differential settlement equal to the estimated total settlement is tolerable and settlement monitoring as described in the **Fill Induced Settlement Considerations** section is performed prior to shallow foundation construction.

Shallow Foundation Design Parameters

Item	Description
Maximum Net Allowable Bearing Pressure [1, 2, 3]	**Oversized footings bearing on native soils or engineered fill** [6]: 1,500 psf **Footings bearing on native soils or engineered fill:** 2,500 psf **Footings bearing on rock**: 5,000 psf
Minimum Foundation Dimensions	Isolated footings: 30 inches Continuous footings: 18 inches
Minimum Embedment below Finished Grade [4]	24 inches
Estimated Total Settlement from Structural Loads [2]	On the order of 1 inch
Estimated Differential Settlement [2, 5, 6]	About 1/2 to 2/3 of total settlement between foundations supported on soil. Up to 1 inch between soil- and rock-supported foundations.

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.

Item	Description

3. Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in **Earthwork**.
4. Embedment necessary to minimize the effects of frost and/or seasonal water content variations.
5. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.
6. Oversized footings could be considered to further decrease differential settlement to achieve an estimated ½ inch of differential settlement measured over a span of 20 feet.

The shallow foundation construction considerations for the **Small Equipment Pads** section are applicable to the shallow foundations for the switching and substation structures.

Floor Slabs

Floor Slab Design Parameters

Item	Description
Floor Slab Support[1,4]	At least 24 inches of subgrade meeting LVC requirements
Granular Leveling Course Layer Thickness [1,2]	4 inches (minimum)
Estimated Modulus of Subgrade Reaction [3]	100 pounds per square inch per inch (psi/in) for point loads

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Well-graded crushed stone (e.g., ODOT Type "A" aggregate base course) or open-graded crushed stone (e.g., ASTM C33, Size No. 57 aggregate) can be used as the leveling course.
3. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

Item	Description

4. LVC may consist of on-site soils or imported material provided that they meet the specifications for LVC as outlined in **Fill Material Types**.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, when the project includes humidity-controlled areas, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Joints should be placed in slabs at regular intervals as recommended by ACI to help control the locations of cracks. Joints or any cracks that develop in the floor slab should be sealed with a waterproof, non-extruding compressible compound.

If floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The structural engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing, or other means.

Floor Slab Construction Considerations

The subgrade should be maintained within the moisture content range recommended for engineered fill until the floor slab is constructed. If the subgrade becomes desiccated before construction of the floor slab, the affected material should be removed or the materials should be scarified, moistened, and compacted. Upon completion of grading operations in the building area, care should be taken to maintain the subgrade within the moisture content and density ranges recommended for engineered fill before construction of the building floor slab.

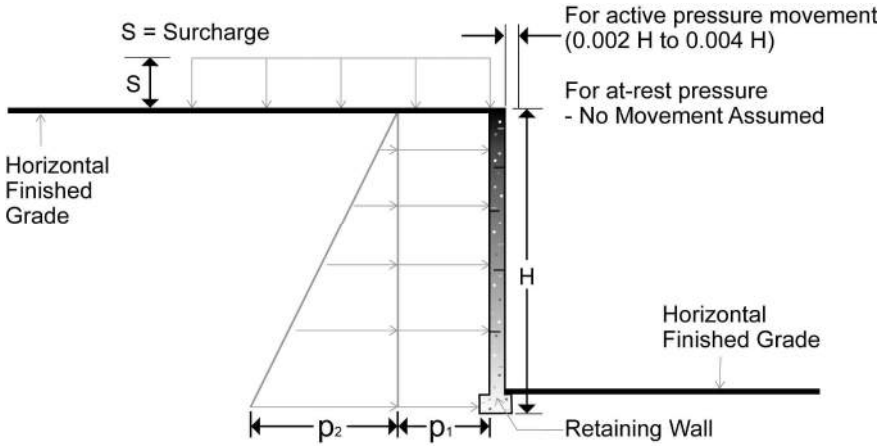
On most project sites, the site grading is generally accomplished early in the construction phase. However, as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, desiccation, rainfall etc. As a result, the floor slab subgrade soils may not be suitable for placement of the granular course or concrete at the time of building construction, and corrective action may be required.

The Geotechnical Engineer should observe the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

Lateral Earth Pressures

Lateral Earth Pressure Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction, methods and degree of compaction, and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls where wall movement is acceptable. The "at-rest" condition assumes no wall movement and is commonly used for design of loading dock walls and other walls that are restrained at the top. The recommended design lateral earth pressures do not include a factor of safety. The drained parameters do not provide for possible hydrostatic pressure on the walls.



Lateral Earth Pressure Design Parameters

Earth Pressure Condition [1]	Coefficient for Backfill Type [2,3]	Surcharge Pressure, p_1 (psf) [4,5]	Equivalent Fluid Unit Weight, p_2 (pcf) [2,5]	
			Drained [6]	Undrained [6]
Active (Ka)	Granular - 0.31 Clay - 0.42	(0.31)S (0.42)S	40 50	80 85
At-Rest (Ko)	Granular - 0.47 Clay - 0.59	(0.47)S (0.59)S	60 70	90 95
Passive (Kp)	Granular - 3.3 Clay - 2.4	--- ---	420 280	290 200

Lateral Earth Pressure Design Parameters

Earth Pressure Condition [1]	Coefficient for Backfill Type [2,3]	Surcharge Pressure, p_1 (psf) [4,5]	Equivalent Fluid Unit Weight, p_2 (pcf) [2,5]	
			Drained [6]	Undrained [6]

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.
2. Uniform, horizontal backfill, with a maximum unit weight of 120 pcf for clay soils and 130 pcf for granular soils.
3. Granular material backfill ϕ = 32 deg. (minimum)
   Clay backfill ϕ = 24 deg. (minimum)
4. Uniform surcharge, where S is surcharge pressure
5. Loading from heavy compaction equipment is not included.
6. To achieve "Drained" conditions, follow guidelines in **Subsurface Drainage for Below-Grade Walls** below. "Undrained" conditions are recommended when drainage behind walls is not incorporated into the design.

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 degrees from vertical for the active case.

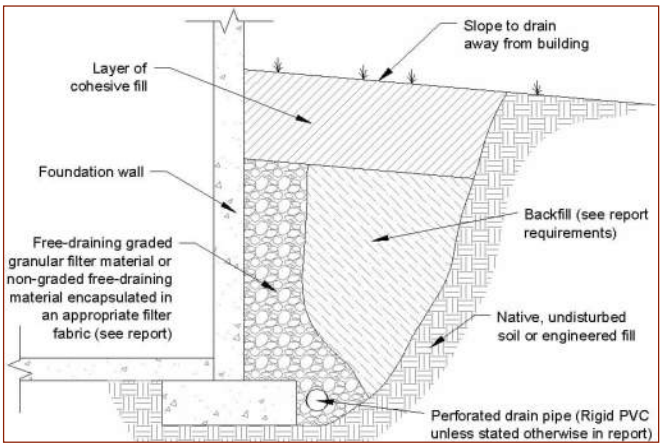
Footings, floor slabs or other loads bearing on backfill behind walls may have a significant influence on the lateral earth pressure. Placing footings within wall backfill and in the zone of active soil influence on the wall should be avoided unless structural analyses show the wall can safely withstand the increased pressure.

The lateral earth pressure recommendations given in this section are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever, or gravity type concrete walls. These recommendations are not applicable to the design of modular block - geogrid reinforced backfill walls (also termed MSE walls). Recommendations covering these types of wall systems are beyond our scope of services for this project. However, we would be pleased to develop a proposal for evaluation and design of such wall systems upon request.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls that extend below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be

surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as ASTM C 33, Size No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a prefabricated drainage structure may be used. A prefabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to limit soil intrusion and is fastened to the wall before placing backfill.

Pavements

General Pavement Comments

A critical aspect of pavement performance is site preparation. Pavement designs noted in this section must be applied to the site which has been prepared as recommended in the **Earthwork** section.

Pavement Design Parameters

A California Bearing Ratio (CBR) of 4 was used for the subgrade for the asphaltic concrete (AC) pavement designs based on laboratory testing performed by Terracon and included in **Exploration Results**. A modulus of subgrade reaction of 150 pci was used for the portland cement concrete (PCC) pavement designs. These values were empirically derived based upon our experience with the lean clay and clayey sand subgrade soils and our expectation of the quality of the subgrade as prescribed by the **Site Preparation** conditions as outlined in **Earthwork**. A modulus of rupture of 550 psi

was used in design for the concrete (based on correlations with a minimum 28-day compressive strength of 4,000 psi).

Pavement Section Thicknesses

The following table provides our opinion of minimum thickness for pavement sections, along the main spine road through the site, which will receive traffic from all three buildings on the campus. This section was designed for an ADT of 2,670 vehicles/day based on an overall campus operating capacity of 600 MW:

Layer	Pavement Section [1]	Minimum Recommended Pavement Section Thickness (in.)				
		Asphaltic Surface Course [2]	Asphaltic Binder Course [2]	Portland Cement Concrete [2] (4000 psi)	Aggregate Base [2]	Total
Heavy Duty+	I	2	8	--	6	16
	II	--	--	10	4	14

1. Pavement Section I: Asphaltic Concrete over Aggregate Base
   Pavement Section II: 4,000 psi, Air-Entrained Portland Cement Concrete (PCC)
2. Oklahoma Department of Transportation Standard Specifications for Highway Construction (2019)

The following table provides our opinion of minimum thickness for pavement sections, for roads leading to individual buildings, which will receive traffic from only one building on campus. This section was designed for an ADT of 1,000 vehicles/day based on an individual data center operating capacity of 200 MW:

Layer	Pavement Section [1]	Minimum Recommended Pavement Section Thickness (in.)				
		Asphaltic Surface Course [2]	Asphaltic Binder Course [2]	Portland Cement Concrete [2] (4000 psi)	Aggregate Base [2]	Total
Standard Duty	I	2	4	--	6	12
	II	--	--	5	4	9
Medium Duty	I	2	5	--	6	13
	II	--	--	7	4	11
Heavy Duty	I	2	6	--	6	14
	II	--	--	8	4	12

1. Pavement Section I: Asphaltic Concrete over Aggregate Base
   Pavement Section II: 4,000 psi, Air-Entrained Portland Cement Concrete (PCC)

2. Oklahoma Department of Transportation Standard Specifications for Highway Construction (2019)

PCC pavements will perform better than ACC in areas where short radius turning and braking is expected (i.e., entrance/exit aprons) due to better resistance to rutting and shoving. In addition, PCC pavement will perform better in areas subject to heavy static loads.

Construction traffic on the pavements was not considered in developing our opinions of minimum pavement thickness. If the pavements will be subject to construction equipment/vehicles, the pavement sections should be revised to consider the additional loading.

Pavements and subgrades will be subject to freeze-thaw cycles and seasonal fluctuations in moisture content. Pavement thickness design methods are intended to provide adequate thickness of structural materials over a particular subgrade such that wheel loads are reduced to a level that the subgrade can support. The subgrade support parameters for pavement thickness design do not account for shrink/swell movements of a subgrade constructed of expansive clay soils. Therefore, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade.

The pavement sections provided above are based on the assumption that the subgrade soils will not experience significant increases in moisture content. Paved areas should be sloped to provide rapid drainage of surface water and to drain water away from the pavement edges. Pavements should be designed so water does not accumulate on or adjacent to the pavement, since this could saturate and soften the subgrade soils and subsequently accelerate pavement deterioration.

Periodic maintenance of the pavements will be required. Cracks should be sealed, and areas exhibiting distress should be repaired promptly to help prevent further deterioration. Even with periodic maintenance, some movement and related cracking may still occur, and repairs may be required.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing

services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Attachments

Exploration and Testing Procedures

Field Exploration

Preliminary Borings[1]	Design-Level Study Locations	Approximate Boring Depth (feet)[2]	Location[3]
6	24	20 to 40 or auger refusal	DC1A
6	24	20 to 40 or auger refusal	DC2A
9	18	20 to 40 or auger refusal	DC3A
0	2	30 to 40	North HUB Building
1	3	20 to 25	South HUB Building
2	5	20 to 24 or auger refusal	Switching Station
0	2	20	Temporary Substation
1	2	20 to 30	Access Drive Building
4	4	20 or auger refusal	Detention Ponds
50	37	20 to 30 or auger refusal	Pavement/driveway and general civil borings

1. Terracon previously performed 79 soil borings as part of our preliminary Geotechnical Report No. 04245081, dated December 12th, 2024. We utilized the available field and laboratory information in addition to our design level borings to aid in our analyses.
2. To account for the anticipated grade cuts, the depth of each borehole varied as shown on the attached boring logs in **Exploration Results**.
3. The preliminary and design level boring locations are shown on the attached **Exploration Plan**.

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. Approximate ground surface elevations were estimated using Google Earth. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with track-mounted and ATV-mounted rotary drill rigs using continuous flight augers and mud-rotary drilling as necessary. Samples were obtained using thin-walled tube and split-barrel sampling procedures. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion. Pavements were patched with cold-mix asphalt and/or pre-mixed concrete, as appropriate.

We also observed the boreholes while auger drilling and at the completion of auger drilling for the presence of groundwater. The groundwater levels are shown on the attached boring logs. In the borings were rock coring was performed, water was introduced into the boreholes as part of the coring process. The drilling fluid masked the depth of groundwater, so water levels were not recorded after the start of the coring.

Upon encountering bedrock or refusal-to-drill conditions, rock coring (using NX rock core barrel) was performed at select locations shown on the attached boring logs in **Exploration Results**. The borings to be cored extended to at least 5 feet below the proposed bearing elevation. Core recovery and RQD values were measured and recorded on the boring logs in accordance with ASTM D6032. Water was used as drilling fluid for rock coring and the spent water was discharged on site.

We also collected bulk samples of auger cuttings from 3 boring locations at each site from depths ranging from below the topsoil layer to 5 feet for laboratory testing.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent our interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Grain Size Analysis
- Atterberg Limits
- California Bearing Ratio
- Moisture-Density Relationship
- Corrosive Suite
- Thermal resistivity
- Unconfined Compressive Strength of Rock

Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Rock classification was conducted using locally accepted practices for engineering purposes in accordance with the attached Rock Classification Notes; petrographic analysis may reveal other rock types.

Corrosivity Testing: Bulk samples of near-surface soils were tested in the laboratory for the following properties in general accordance with the corresponding standards:

- pH Analysis (ASTM G51)
- Chloride (ASTM D512)
- Sulfate (ASTM C1580)
- Sulfide Content (AWWA 4500-S D)
- Oxidation-Reduction Potential (ASTM G200)
- Electrical Resistivity Testing (ASTM G187)

Unconfined Compressive Strength Testing Results

Unconfined compressive strength testing on rock core samples obtained during field exploration was performed or attempted on the following specimens.

Boring ID	Depth	Unconfined Compressive Strength (psi)
B-195	20 to 25	Too fragile [1]
	25 to 30	Too fragile [1]
B-197	10 to 15	Too fragile [1]
	15 to 20	3,399
	20 to 25	1,573

Boring ID	Depth	Unconfined Compressive Strength (psi)
	25 to 30	Too fragile [1]
B-199	20 to 25	Too fragile [1]
	25 to 30	Too fragile [1]
B-203	15 to 20	Too fragile [1]
	20 to 25	Too fragile [1]
	25 to 30	Too fragile [1]
B-207	20 to 25	Too fragile [1]
	25 to 30	1,781
B-217	20 to 25	Too fragile [1]
	25 to 30	Too fragile [1]
B-221	20 to 25	6,696
	25 to 30	Too fragile [1]
B-227	20 to 25	Too fragile [1]
B-228	10 to 15	6,315
	15 to 20	4,575
	20 to 25	6,896
	25 to 30	Too fragile [1]
	30 to 35	4,475
	35 to 40	4,861
B-156	10 to 15	1,377
	15 to 20	3,268
	20 to 25	2,397
	25 to 30	Too fragile [1]
B-158	10 to 15	3,333
	15 to 20	Too fragile [1]
	20 to 25	4,327
	25 to 30	3,711
B-165	10 to 15	3,383
	15 to 20	1,773
	20 to 25	1,499
	25 to 30	3,408
B-166	15 to 20	3,412
	20 to 25	Too fragile [1]
	25 to 30	3,382
	30 to 35	1,684
B-167	10 to 15	2,975
	15 to 20	4,426
	20 to 25	Too fragile [1]
	25 to 30	5,233

Boring ID	Depth	Unconfined Compressive Strength (psi)
B-170	10 to 15	Too fragile [1]
	15 to 20	Too fragile [1]
B-176	15 to 20	2,252
	20 to 25	Too fragile [1]
	25 to 30	3,003
	30 to 35	3,203
	35 to 40	2,289
B-181	15 to 20	4,583
	20 to 25	2,790
	25 to 30	Too fragile [1]
B-186	14 to 19	4,860
	19 to 24	4,664
B-187	14 to 19	5,073
	19 to 24	3,660
B-103	10 to 15	4,353
	15 to 20	4,720
	20 to 25	5,444
	25 to 30	5,892
B-105	10 to 15	4,502
	15 to 20	4,374
	20 to 25	6,433
	25 to 30	5,815
B-106	10 to 15	1,778
	15 to 20	Too fragile [1]
B-107	10 to 15	1,880
	15 to 20	2,924
B-108A	10 to 14	Too fragile [1]
	14 to 19	Too fragile [1]
	19 to 24	Too fragile [1]
	24 to 29	6,220
B-109	10 to 15	Too fragile [1]
	15 to 20	Too fragile [1]
	20 to 25	Too fragile [1]
	25 to 30	Too fragile [1]
B-125A	10 to 15	Too fragile [1]
	15 to 20	7,736
B-126	10 to 15	Too fragile [1]
	15 to 20	3,614
	20 to 25	4,918

Boring ID	Depth	Unconfined Compressive Strength (psi)
	25 to 30	4,224
B-131	10 to 15	Too fragile [1]
	15 to 20	Too fragile [1]
	20 to 25	1,673
	25 to 30	Too fragile [1]
B-137	10 to 15	Too fragile [1]
	15 to 20	Too fragile [1]
B-141	15 to 20	5,033
	20 to 25	Too fragile [1]
	25 to 30	Too fragile [1]
B-148	10 to 15	Too fragile [1]
	15 to 20	Too fragile [1]
B-151	10 to 15	2,430
	15 to 20	1,924
	20 to 25	1,958
	25 to 30	4,663

1. Samples of shale taken at the site were prone to fracturing and slaking during the preparation process for unconfined compressive strength testing. Some samples were too fragile to be prepared for a representative unconfined compressive strength test. This does not necessarily mean that the shale that is too fragile for testing is low strength material, as in-situ properties of shale can vary greatly from unconfined samples.

Site Location and Exploration Plans

Contents:

Site Location Plan
Exploration Plan (4 pages)
Seismic Refraction Testing Locations

Note: All attachments are one page unless noted above.

Site Location

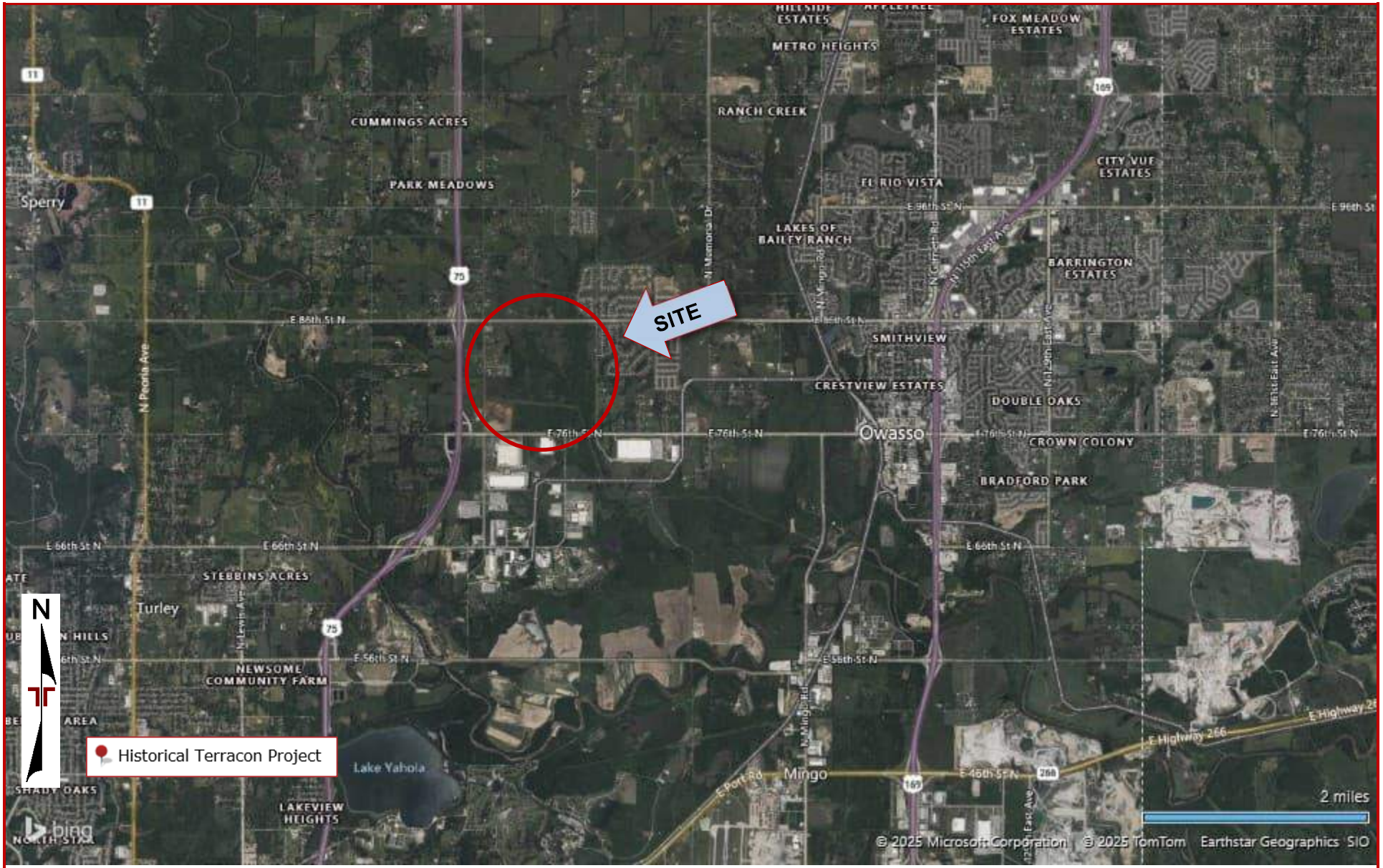


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan (Phase 1; 1 of 4)

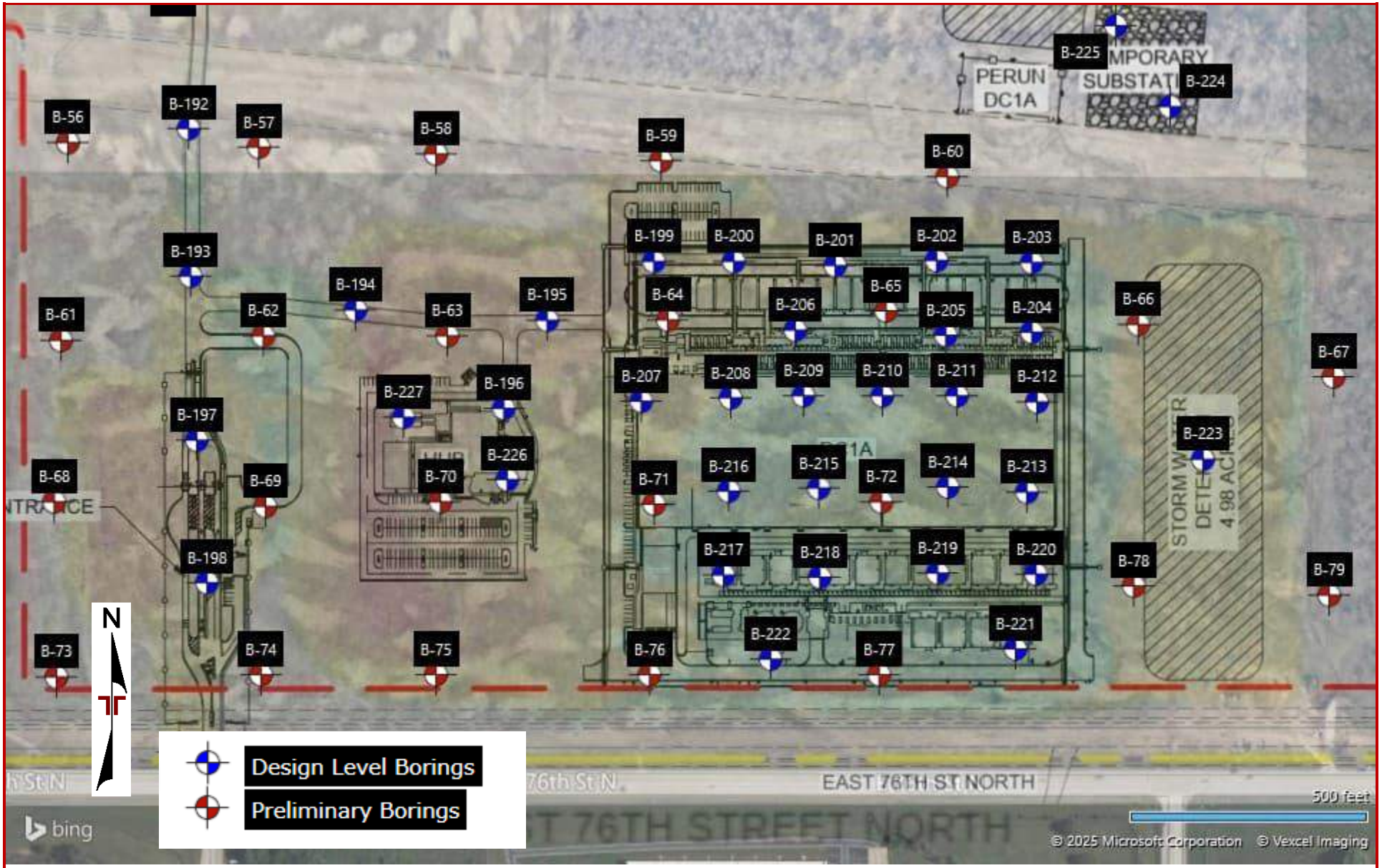


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan (Phase 2; 2 of 4)

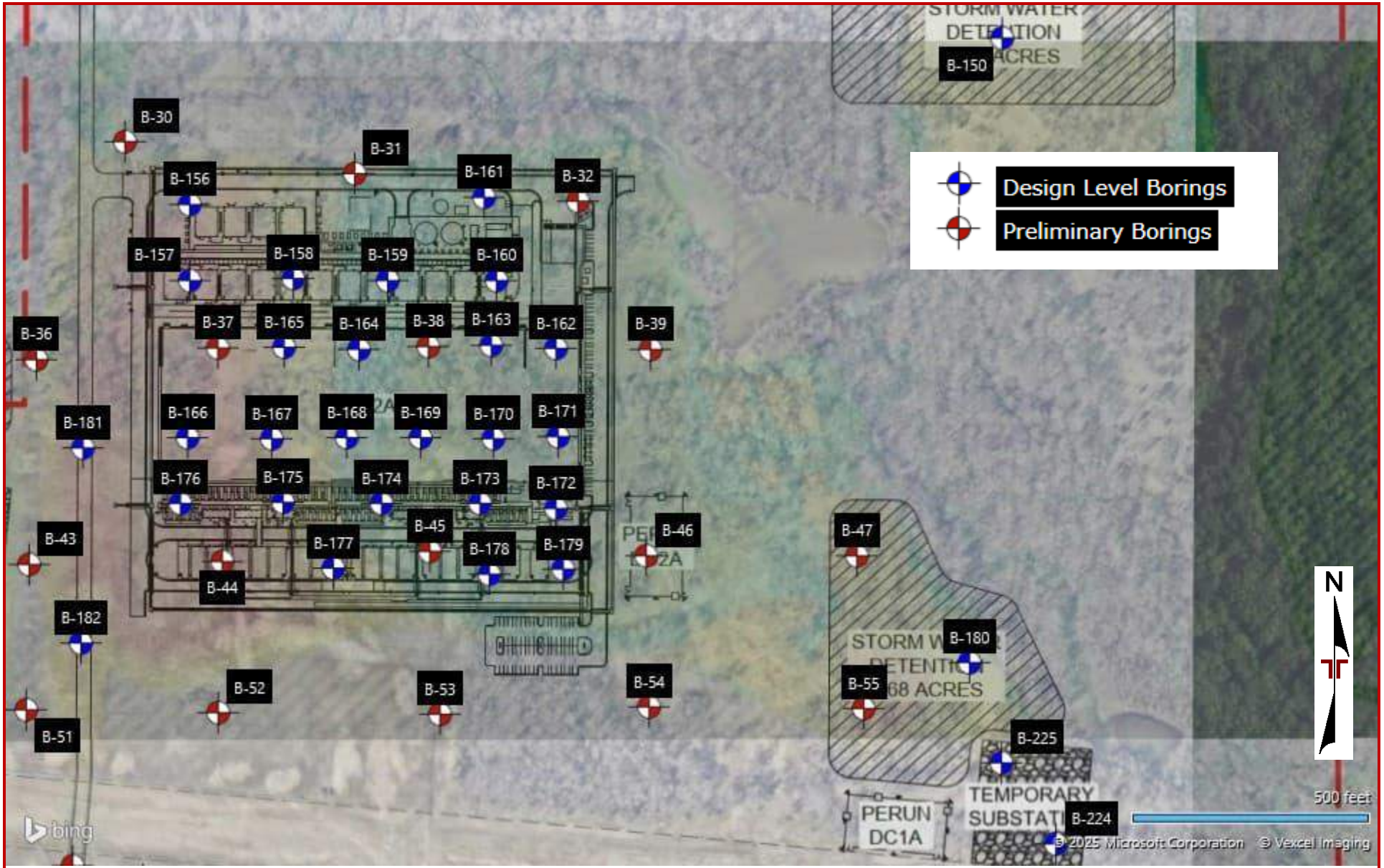


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan (Phase 2; 3 of 4)

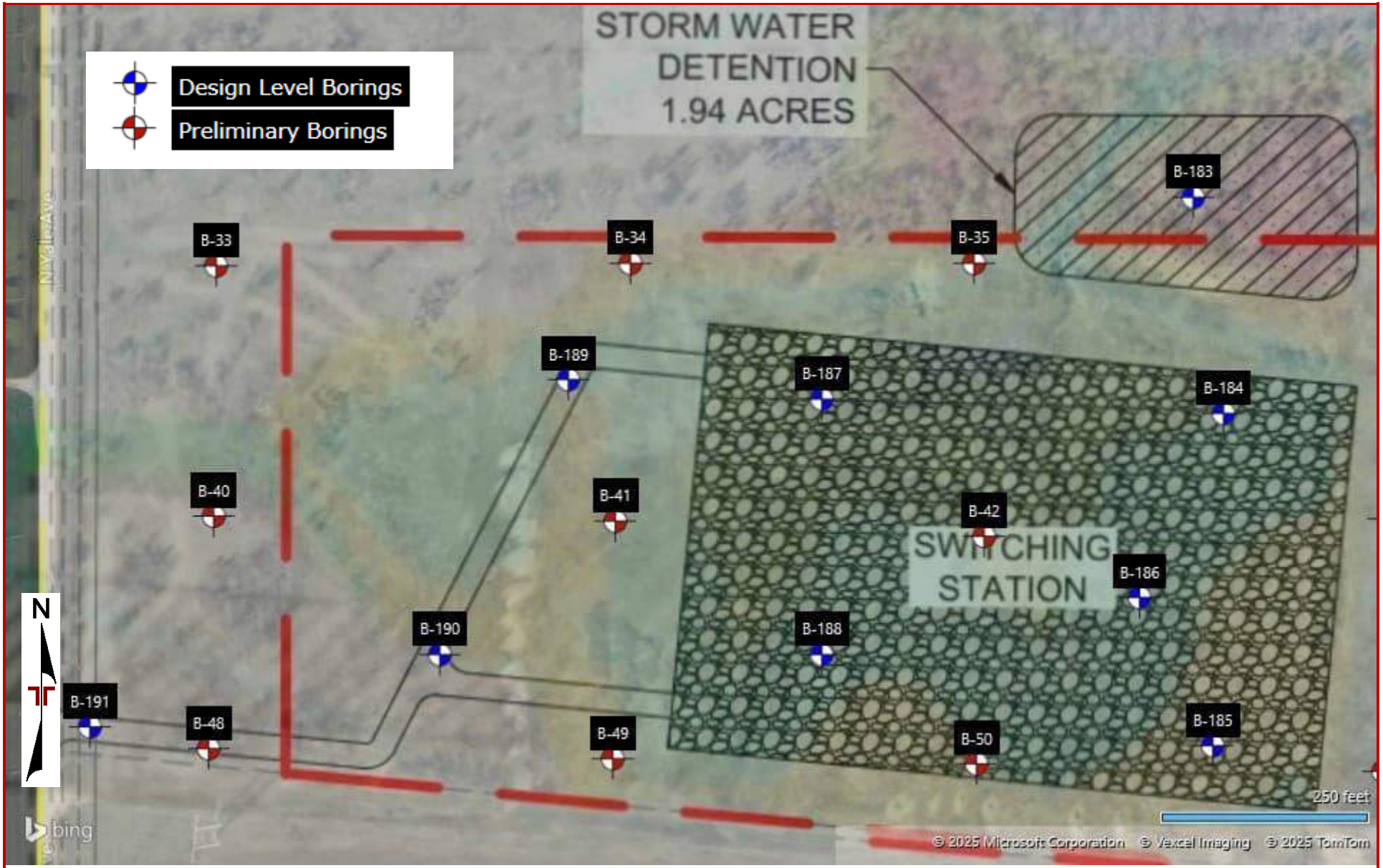


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan (Phase 3; 4 of 4)

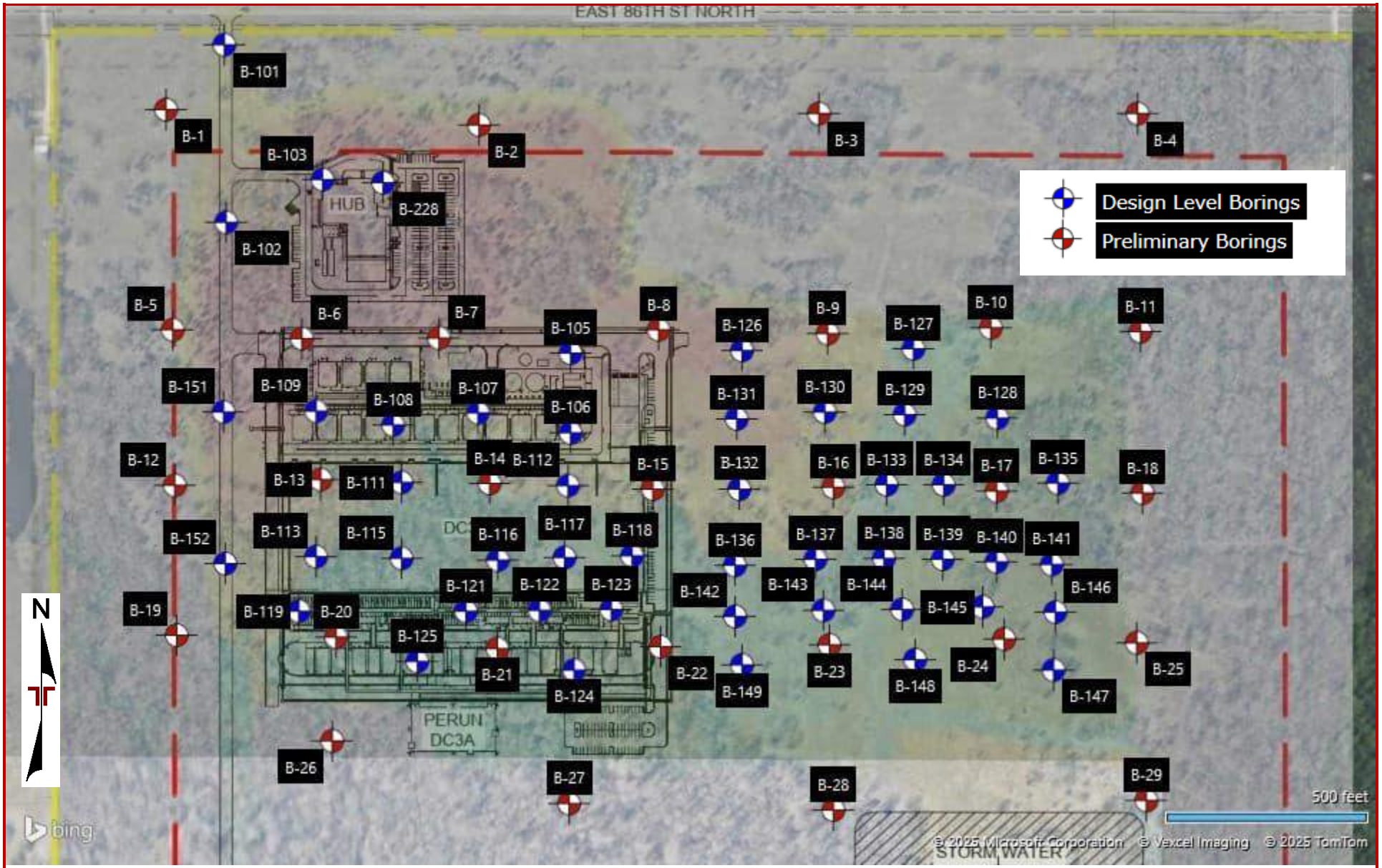


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Seismic Refraction Line (SR-X)

0 1000 2000 3000
Feet

N

Terracon

Date: 06/2025 | Project Number: 04255087

Line Location Map	Exhibit
Project Clydesdale Owasso, Oklahoma	1

Exploration and Laboratory Results

Contents:

Preliminary Boring Logs (B-1 through B-79)
Boring Logs (B-101 through B-230)
Seismic Refraction Testing Results (10 pages)
Atterberg Limits (7 pages)
Grain Size Distribution (24 pages)
California Bearing Ratio Testing Results (5 pages)
Standard Proctor Testing Results (3 pages)
Corrosive Suite Testing Results (3 pages)
Thermal Resistivity Testing Results (4 pages)

Note: All attachments are one page unless noted above.

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-1

Location: See Exploration Plan

Latitude: 36.2778° Longitude: -95.9145°

Depth (Ft.) Elevation: 687 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil **LEAN CLAY (CL)**, brown and olive brown, soft 2.0 685			18	0-0-3 N=3		25.4			
1		**LEAN CLAY (CL)**, with sandstone seams, brown and olive brown, very stiff to hard			18	4-7-9 N=16		13.4		35-19-16	
					18	7-15-25 N=40		12.6			
		5			18	30-29-14 N=43		14.2			
		8.5 678.5									
2		**SANDSTONE+**, brown, well cemented 10.0 677			1	50/1"		6.5			
		10									
		Auger Refusal on sandstone at 10 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-14-2024

Boring Completed
11-14-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-2

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 36.2777° Longitude: -95.9118° Depth (Ft.) Elevation: 691 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2		Approximately 6" Topsoil **SANDSTONE+**, brown and reddish brown, poorly cemented to well cemented				12	9-29-47 N=76		6.6			
						6	50/6"		4.8			
						2	50/2"		10.1			
			5			1	50/1"		9.2			
		7.0 684 ***Auger Refusal on sandstone at 7 Feet***										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-14-2024

Boring Completed
11-14-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-3

Location: See Exploration Plan

Latitude: 36.2778° Longitude: -95.9090°

Depth (Ft.) Elevation: 670 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed **SILTY LEAN CLAY (CL-ML)**, brown, reddish brown and gray, soft									
1		2.0 668			18	0-1-2 N=3		20.4		28-21-7	
		SHALEY LEAN CLAY (CL), brown, gray and reddish brown, very stiff			18	7-9-11 N=20		10.8			
		4.0 666			18	8-25-38 N=63		9.0		38-18-20	
		SHALE+, olive brown and gray, soft			12	35-50/6"		10.2			
2					6	50/6"		8.9			
					5	50/5"		10.6			
		18.5 651.5 18.6 **SHALE+**, gray, hard 651.4			1	50/1"		4.7			
		Boring Terminated at 18.6 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-14-2024

Boring Completed
11-14-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-4

Location: See Exploration Plan

Latitude: 36.2778° Longitude: -95.9063°

Depth (Ft.) Elevation: 643 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed **LEAN CLAY (CL)**, brown, gray and reddish brown, medium stiff to stiff									
					18	0-2-3 N=5		21.5			
					18	3-4-5 N=9		16.8			
					18	4-8-8 N=16		19.7		34-17-17	
		5.0 638									
1		**SHALEY LEAN CLAY (CL)**, brown, gray and reddish brown, very stiff			18	12-12-13 N=25		10.7			
					18	10-15-14 N=29		6.3			
		13.5 629.5									
2		**SHALE+**, gray, hard			2	50/2"		6.9			
		18.7 624.3			2	50/2"		6.6			
		Boring Terminated at 18.7 Feet									

5 10 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-14-2024

Boring Completed
11-14-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-5

Location: See Exploration Plan

Latitude: 36.2763° Longitude: -95.9144°

Depth (Ft.) Elevation: 686 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **LEAN CLAY (CL)**, brown and reddish brown, very stiff 2.0 684			18	3-7-17 N=24		18.6			
2		**SANDSTONE+**, olive brown and gray, cemented to well cemented			4	50/4"		9.9			
					2	50/2"		7.8			
					2	50/2"		8.5			
					0	50/0"					
		13.5 672.5									
		SHALE+, gray, moderately hard to hard			3	50/3"		6.6			
		18.6 667.4			1	50/1"		7.2			
		Boring Terminated at 18.6 Feet									

5 10 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-13-2024

Boring Completed
11-13-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-6

Location: See Exploration Plan

Latitude: 36.2764° Longitude: -95.9132°

Depth (Ft.) Elevation: 692 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed									
1		**LEAN CLAY (CL)**, brown, reddish brown and gray, medium stiff to very stiff			18	3-3-2 N=5		18.0		30-21-9	
					18	3-7-15 N=22		20.9			
		3.5 688.5									
		SHALEY LEAN CLAY (CL), brown, reddish brown and gray, hard			18	13-21-24 N=45		8.8			
		5.0 687									
2		**SHALE+**, sandstone seams, olive brown and gray, soft			6	50/6"		7.5			
					5	50/5"		10.0			
		13.5 678.5									
		SHALE+, gray, moderately hard to hard			3	50/3"		7.9			
		18.6 673.4			1	50/1"		5.7			
		Boring Terminated at 18.6 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-13-2024

Boring Completed
11-13-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-7

Location: See Exploration Plan

Latitude: 36.2763° Longitude: -95.9116°

Depth (Ft.) Elevation: 675 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Dozed **LEAN CLAY (CL)**, olive and reddish brown, medium stiff 2.0 673									
					18	2-1-4 N=5		26.4			
					18	17-24-31 N=55		10.8		28-19-9	
					11	30-50/5"		8.9			
		5									
					18	21-25-31 N=56		9.6			
					8	37-50/2"		24.8			
2		10									
					3	50/3"		10.4			
		15									
		18.5 656.5 18.6 **SHALE+**, gray, hard 656.4 ***Boring Terminated at 18.6 Feet***			1	50/1"		8.4			

SHALE+, olive brown and gray, soft to hard

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-19-2024

Boring Completed
11-19-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-8

Location: See Exploration Plan

Latitude: 36.2763° Longitude: -95.9103°

Depth (Ft.) Elevation: 666 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **LEAN CLAY (CL)**, with sand, brown and reddish brown, very stiff 2.0 664			18	0-5-19 N=24		7.0			84
2		**SHALE+**, brown and olive brown, soft to hard			18	26-40-45 N=85		7.1			
					3	50/3"		15.7			
		5			4	50/4"		8.0			
					2	50/2"		7.9			
		10			4	50/4"		8.2			
		15									
		18.5 647.5 18.6 **SHALE+**, gray, hard 647.4			1	50/1"		4.2			
		Boring Terminated at 18.6 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-19-2024

Boring Completed
11-19-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-9

Location: See Exploration Plan

Latitude: 36.2762° Longitude: -95.9088°

Depth (Ft.) Elevation: 651 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil									
1		**LEAN CLAY (CL)**, olive brown and reddish brown, soft			18	0-0-4 N=4		25.5		32-21-11	
		2.0 649									
		SHALEY LEAN CLAY (CL), brown and olive brown, very stiff			18	10-11-14 N=25		12.1			
		3.5 647.5									
2		**SHALE+**, brown and olive brown, soft			10	41-50/4"		8.8			
					5	50/5"		11.7			
		8.5 642.5									
		SHALE+, brown, moderately hard to hard			3	50/3"		10.6			
					2	50/2"		9.6			
		18.5 632.5									
		18.8 **SHALE+**, gray, moderately hard to hard 632.2			3	50/3"		7.1			
		Boring Terminated at 18.8 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-19-2024

Boring Completed
11-19-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-10

Location: See Exploration Plan

Latitude: 36.2763° Longitude: -95.9075°

Depth (Ft.) | Elevation: 640 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **FAT CLAY (CH)**, brown, gray and reddish brown, stiff				0-3-5 N=8		26.8		51-22-29	
		2.0 638									
		SHALEY LEAN CLAY (CL), brown, reddish brown and gray, hard				13-20-24 N=44		12.5			
		4.0 636									
2		**SHALE+**, olive brown and gray, soft to hard				12-35-50/5"		12.8			
					6	50/6"		10.6			
					4	50/4"		9.5			
					8	27-50/2"		14.6			
		18.8 621.2			4	50/4"		9.7			
		Boring Terminated at 18.8 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-14-2024

Boring Completed
11-14-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-11

Location: See Exploration Plan

Latitude: 36.2763° Longitude: -95.9062°

Depth (Ft.) Elevation: 633 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed **SILTY LEAN CLAY (CL-ML)**, brown, reddish brown and gray, stiff to very stiff									
		3.5 629.5			8	2-4-5 N=9		12.5			
					18	3-5-9 N=14		8.3		25-18-7	
1		**SHALEY LEAN CLAY (CL)**, brown, gray and reddish brown, very stiff			18	10-15-15 N=30		8.7			
					18	11-9-10 N=19		8.8			
		8.5 624.5									
		SHALE+, gray, soft to hard			8	30-50/2"		11.2			
2					3	50/3"		6.9			
		18.7 614.3			2	50/2"		6.5			
		Boring Terminated at 18.7 Feet									

5 10 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-14-2024

Boring Completed
11-14-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-12

Location: See Exploration Plan

Latitude: 36.2753° Longitude: -95.9144°

Depth (Ft.) Elevation: 670 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Dozed **LEAN CLAY (CL)**, with silt lenses, very stiff to hard			18	2-7-15 N=22		9.5		28-20-8	
		3.0 667				17-30-50/4"		8.1			
2		**SHALE+**, sandstone seams, olive brown and gray, soft to moderately hard				50/6"		5.3			
		5				50/4"		8.4			
						30-50/3"		9.9			
		10									
		13.5 656.5									
		SHALE+, gray, moderately hard to hard				50/2"		6.6			
		15									
		18.8 651.2				50/3"		6.3			
		Boring Terminated at 18.8 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-13-2024

Boring Completed
11-13-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-13

Location: See Exploration Plan

Latitude: 36.2753° Longitude: -95.9132°

Depth (Ft.) Elevation: 667 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil **LEAN CLAY (CL)**, brown, olive brown and reddish brown, soft 2.0 665									
					18	0-0-2 N=2		22.0			
		SHALEY LEAN CLAY (CL), brown, reddish brown and olive brown, very stiff			18	8-11-18 N=29		13.5			
1					18	11-15-11 N=26		11.5		32-18-14	93
					18	8-11-15 N=26		13.4		31-19-12	
		8.5 658.5									
		SHALE+, olive brown and gray, soft to hard			11	25-50/5"		10.3			
2					0	50/0"					
		19.3 647.7			10	20-50/4"		11.3			
		Boring Terminated at 19.3 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-13-2024

Boring Completed
11-13-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-14

Location: See Exploration Plan

Latitude: 36.2753° Longitude: -95.9117°

Depth (Ft.) Elevation: 657 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil **LEAN CLAY (CL)**, brown and olive brown, soft									
					18	2-3-4 N=7		23.0			
		3.5 653.5									
					18	4-6-12 N=18		15.5			
1		**LEAN CLAY (CL)**, brown and olive brown, stiff to hard			18	11-23-29 N=52		10.0			
					12	19-50/6"		10.9			
		8.5 648.5									
		SHALE+, brown, soft			6	50/6"		10.0			96
2		13.5 643.5									
		SHALE+, gray, hard			2	50/2"		6.6			
		18.6 638.4									
		Boring Terminated at 18.6 Feet			1	50/1"					

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-19-2024

Boring Completed
11-19-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-15

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 36.2752° Longitude: -95.9104° Depth (Ft.) Elevation: 652 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Dozed **LEAN CLAY (CL)**, brown and olive brown, medium stiff 2.0 650				18	1-3-3 N=6		21.1			
2		**SHALE+**, brown, soft to moderately hard	5			18	14-21-50/5"		9.7			
						10	12-50/4"		10.4			
						4	50/4"		8.4			
			10			3	50/4"		7.9			
		13.0 639 ***Auger Refusal on sandstone at 13 Feet***										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-17-2024

Boring Completed
11-17-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-16

Location: See Exploration Plan

Latitude: 36.2753° Longitude: -95.9088°

Depth (Ft.) | Elevation: 642 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Dozed **LEAN CLAY (CL)**, dark brown, medium stiff									
		2.0 / 640			18	0-3-3 N=6		21.6			
2		**SHALE+**, olive brown, soft to hard			18	10-20-35 N=55		10.5			
					9	26-50/3"		8.4			
		5			1	50/1"		6.5			
					2	50/2"		7.9			
		10			6	50/6"		9.5			
		15									
		18.5 / 623.5									
		18.8 **SHALE+**, gray, moderately hard / 623.2			4	50/4"		9.2		33-21-12	
		Boring Terminated at 18.8 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-14-2024

Boring Completed
11-14-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-17

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 36.2752° Longitude: -95.9075° Depth (Ft.) Elevation: 629 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed										
1		**LEAN CLAY (CL)**, brown and reddish brown, medium stiff				18	0-2-3 N=5		23.7		36-19-17	
1		2.0 627										
1		**SHALEY LEAN CLAY (CL)**, brown, gray and reddish brown, very stiff				18	11-14-15 N=29		14.6			88
1			5			18	8-12-10 N=22		17.7			
1						18	12-14-15 N=29		14.7			
1												
1						18	6-7-8 N=15		13.3			
1			10									
2		**SHALE+**, gray and olive brown, soft				18	15-26-40 N=66		13.1			
2		18.5 610.5	15									
2		18.8 **SHALE+**, gray, moderately hard 610.2				3	50/3"		7.1			
		Boring Terminated at 18.8 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-14-2024

Boring Completed
11-14-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-18

Location: See Exploration Plan

Latitude: 36.2752° Longitude: -95.9062°

Depth (Ft.) Elevation: 627 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed **SILTY LEAN CLAY (CL-ML)**, brown, gray and reddish brown, soft to medium stiff			18	0-0-0 N=0		22.2		25-18-7	
					18	0-1-4 N=5		20.0			
1		**SHALEY LEAN CLAY (CL)**, brown, gray and reddish brown, very stiff to hard			18	4-8-9 N=17		16.4			
					18	11-16-29 N=45		13.4			
2		**SHALE+**, gray, moderately hard to hard			3	50/3"		7.0			
					2	50/2"		7.1			
					2	50/2"					
		Boring Terminated at 18.7 Feet									

3.5 623.5
8.5 618.5
18.7 608.3

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-14-2024

Boring Completed
11-14-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-19

Location: See Exploration Plan

Latitude: 36.2742° Longitude: -95.9144°

Depth (Ft.) Elevation: 652 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed **SILTY LEAN CLAY (CL-ML)**, brown, reddish brown and gray, medium stiff 2.0 650									
					18	0-1-4 N=5		20.5		24-19-5	
1		**SHALEY LEAN CLAY (CL)**, brown, reddish brown and gray, hard			18	9-17-22 N=39		11.8			
					18	16-23-22 N=45		9.3			
					18	17-30-37 N=67		7.3			
		8.5 643.5									
		SHALE+, gray, moderately hard to hard			4	50/4"		7.9			
2					3	50/3"		5.8			
		18.6 633.4			1	50/1"		4.8			
		Boring Terminated at 18.6 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-13-2024

Boring Completed
11-13-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-20

Location: See Exploration Plan

Latitude: 36.2742° Longitude: -95.9130°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 650 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
			Approximately 6" Topsoil										
1		2.0	**LEAN CLAY (CL)**, brown, reddish brown and gray, medium stiff				18	2-2-5 N=7		17.3		31-17-14	
							18	7-7-7 N=14		14.2			92
				5			18	5-7-8 N=15		15.6			
							18	8-10-7 N=17		10.8		31-17-14	
		8.5	**SHALEY LEAN CLAY (CL)**, brown, gray and reddish brown, stiff to very stiff										
2			**SHALE+**, olive brown and gray, soft to hard	10			8	30-50/2"		11.4			
							8	38-50/2"		10.5			
		18.5		15									
		18.6	**SHALE+**, gray, hard				1	50/1"		6.4			
			Boring Terminated at 18.6 Feet										

641.5
631.5
631.4

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-13-2024

Boring Completed
11-13-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-21

Location: See Exploration Plan

Latitude: 36.2742° Longitude: -95.9117°

Depth (Ft.) Elevation: 646 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed **LEAN CLAY (CL)**, reddish brown, medium stiff to stiff									
		3.5 642.5			18	2-2-3 N=5		20.2			
		SHALEY LEAN CLAY (CL), olive brown and brown, very stiff to hard			18	3-4-10 N=14		18.5			
					18	15-17-17 N=34		10.3			
		5			12	18-18-20 N=38		9.9		35-17-18	
1											
					15	17-15-15 N=30		11.5			
		10									
		14.0 632			8	25-50/2"		13.4			
2		**SHALE+**, olive brown, hard									
		15									
		18.5 627.5									
		18.8 **SHALE+**, gray, moderately hard 627.2			3	50/3"		6.5			
		Boring Terminated at 18.8 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-15-2024

Boring Completed
11-15-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-22

Location: See Exploration Plan

Latitude: 36.2742° Longitude: -95.9103°

Depth (Ft.) Elevation: 641 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed									
1		**SHALEY LEAN CLAY (CL)**, olive brown, hard			18	14-17-17 N=34		14.2			
					18	15-22-28 N=50		8.5		31-21-10	
		3.5 637.5									
		SHALEY LEAN CLAY (CL), olive brown and brown, hard			18	21-27-34 N=61		10.8			
		5.0 636									
2		**SHALE+**, olive and reddish brown, soft to moderately hard			6	50/6"		11.9			
					9	28-50/3"		13.5			
					5	50/5"		8.3			
		18.5 622.5									
		18.7 **SHALE+**, gray, hard 622.3			2	50/2"		6.2			
		Boring Terminated at 18.7 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-15-2024

Boring Completed
11-15-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-23

Location: See Exploration Plan

Latitude: 36.2742° Longitude: -95.9089°

Depth (Ft.) Elevation: 636 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil									
1		**LEAN TO FAT CLAY (CL/CH)**, reddish brown, very stiff			18	0-3-16 N=19		20.6			
		2.0 634									
		SHALEY LEAN CLAY (CL), brown and reddish brown, hard			18	16-22-22 N=44		10.8			
		3.5 632.5									
2		**SHALE+**, brown, soft			12	21-50/6"		11.2			
					6	50/6"		7.5		34-22-12	
					6	50/6"		8.2			
					5	50/5"		8.0			95
		18.5 617.5									
		18.8 **SHALE+**, gray, moderately hard 617.2			3	50/3"		6.5			
		Boring Terminated at 18.8 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-19-2024

Boring Completed
11-19-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-24

Location: See Exploration Plan

Latitude: 36.2742° Longitude: -95.9074°

Depth (Ft.) Elevation: 630 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed **LEAN CLAY (CL)**, brown, olive and reddish brown, stiff									
		2.0 628									
1		**SHALEY LEAN CLAY (CL)**, olive brown, very stiff			18	0-2-8 N=10		23.8			
					18	12-12-12 N=24		16.7			94
					18	7-9-10 N=19		18.7			
		5			18	9-10-11 N=21		16.4			
					18	6-11-13 N=24		13.7			
		10									
		14.0 616			7	25-50/1"		14.7			
2		**SHALE+**, gray, hard									
		15									
		18.6 611.4			1	50/1"		7.2			
		Boring Terminated at 18.6 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-15-2024

Boring Completed
11-15-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-25

Location: See Exploration Plan

Latitude: 36.2742° Longitude: -95.9063°

Depth (Ft.) Elevation: 626 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil **SHALEY LEAN CLAY (CL)**, brown, gray and reddish brown, very stiff to hard									
1					18	0-6-12 N=18		10.1			
					18	12-13-14 N=27		9.6		37-17-20	
					18	12-13-13 N=26		12.0			
		5			18	16-20-21 N=41		12.3			
		8.5 617.5									
2		**SHALE+**, gray, soft to hard			11	25-50/5"		13.6			
		10									
					4	50/4"		8.4			
		15									
		18.7 607.3				50/2"		6.7			
		Boring Terminated at 18.7 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-14-2024

Boring Completed
11-14-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-26

Location: See Exploration Plan

Latitude: 36.2735° Longitude: -95.9131°

Depth (Ft.) Elevation: 649 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Dozed **LEAN CLAY (CL)**, brown and reddish brown, very stiff			18	2-7-11 N=18		16.6			
					18	9-12-15 N=27		15.8			
		3.5 645.5									
2		**SHALE+**, brown, soft			18	14-15-19 N=34		8.4			
		5			6	50/6"		8.6			
					6	50/6"		9.1		28-19-9	
		10									
		13.5 635.5									
		SHALE+, gray, hard			2	50/2"		10.2			
		15									
		18.5 630.5									
		Boring Terminated at 18.5 Feet			0	50/0"					

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller

Logged by

Boring Started
11-15-2024

Boring Completed
11-15-2024

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-27

Location: See Exploration Plan

Latitude: 36.2731° Longitude: -95.9111°

Depth (Ft.) Elevation: 642 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed **LEAN CLAY (CL)**, olive brown and reddish brown, soft to medium stiff			18	1-2-2 N=4		21.1			
					18	3-3-3 N=6		19.1			
					18	2-3-3 N=6		18.3			
		5.0 637									
1		**SHALEY LEAN CLAY (CL)**, olive brown, very stiff			18	9-9-10 N=19		9.6		26-17-9	
					18	8-10-10 N=20		11.2			
		13.5 628.5									
2		**SHALE+**, gray, moderately hard to hard			2	50/2"		8.4			
		18.6 623.4			1	50/1"		6.3			
		Boring Terminated at 18.6 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by

Boring Started
11-15-2024

Boring Completed
11-15-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-28

Location: See Exploration Plan

Latitude: 36.2730° Longitude: -95.9088°

Depth (Ft.) Elevation: 634 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed **LEAN CLAY (CL)**, brown and reddish brown, medium stiff to stiff									
		3.5 630.5			18	1-2-3 N=5		21.0			
					18	4-5-7 N=12		17.2			
		SHALEY LEAN CLAY (CL), brown and olive brown, very stiff to hard			18	5-5-7 N=12		16.7		35-17-18	
					18	8-19-27 N=46		12.4			
1											
					18	17-15-12 N=27		12.7			99
		13.5 620.5									
		SHALE+, gray, soft to hard			6	50/6"		9.8			
2											
		18.7 615.3			2	50/2"		7.0			
		Boring Terminated at 18.7 Feet									

5 10 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-15-2024

Boring Completed
11-15-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-29

Location: See Exploration Plan

Latitude: 36.2731° Longitude: -95.9062°

Depth (Ft.) Elevation: 628 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed									
1		**LEAN CLAY (CL)**, reddish brown, soft			18	0-0-3 N=3		26.0			
1		2.0 626									
1		**SHALEY LEAN CLAY (CL)**, brown and olive brown, stiff to hard			18	4-6-8 N=14		12.7		34-16-18	
1					18	9-14-15 N=29		14.3		39-20-19	
1		5			18	17-22-22 N=44		14.4			
1					18	12-14-14 N=28		15.4			
1		10									
2		**SHALE+**, brown, soft to moderately hard			5	50/5"		4.9			
2		15									
2		18.8 609.2			0	50/4"					
		Boring Terminated at 18.8 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-15-2024

Boring Completed
11-15-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-30

Location: See Exploration Plan

Latitude: 36.2720° Longitude: -95.9137°

Depth (Ft.) Elevation: 659 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed **SILTY LEAN CLAY (CL-ML)**, brown, reddish brown and gray, soft 2.0 / 657									
1		**SHALEY LEAN CLAY (CL)**, brown, gray and reddish brown, very stiff to hard			18	0-0-4 N=4		20.1		26-19-7	
					18	15-19-25 N=44		11.8			
					18	11-12-11 N=23		12.7		26-16-10	
					18	8-9-11 N=20		12.0			
					18	9-14-16 N=30		9.7			
2		**SHALE+**, olive brown and gray, soft to moderately hard 13.5 / 645.5			9	40-50/3"		9.2			
		18.8 / 640.2			3	50/3"		8.6			
		Boring Terminated at 18.8 Feet									

5 10 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-12-2024

Boring Completed
11-12-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-31

Location: See Exploration Plan

Latitude: 36.2718° Longitude: -95.9121°

Depth (Ft.) Elevation: 641 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Dozed **SHALEY LEAN CLAY (CL)**, brown, reddish brown and gray, stiff to hard			18	4-15-18 N=33		27.3			
					18	15-16-22 N=38		10.3			
					18	12-13-12 N=25		12.6		29-17-12	
		5				10-12-13 N=25		12.6			
					18	7-6-4 N=10		14.4			
		10									
					18	3-6-8 N=14		16.4			
		15									
		18.5 622.5									
2		**SHALE+**, olive brown and gray, soft to moderately hard 19.3 621.7			8	30-50/3"		12.0			
		Boring Terminated at 19.3 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-12-2024

Boring Completed
11-12-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-32

Location: See Exploration Plan

Latitude: 36.2717° Longitude: -95.9106°

Depth (Ft.) Elevation: 636 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed									
1		**LEAN CLAY (CL)**, brown, olive brown and gray, very stiff			18	0-4-13 N=17		14.0		30-18-12	
1		2.0 634									
1		**SHALEY LEAN CLAY (CL)**, brown, olive brown and gray, very stiff to hard			18	13-15-17 N=32		11.7			
1					18	9-12-10 N=22		12.6			91
1					18	10-11-12 N=23		12.9			
1											
1					18	8-11-12 N=23		12.0			
1											
2		**SHALE+**, olive brown and gray, soft			12	36-50/6"		14.1			
2		18.9 617.1				50/5"		7.4			
		Boring Terminated at 18.9 Feet									

5 10 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-11-2024

Boring Completed
11-11-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-33

Location: See Exploration Plan

Latitude: 36.2704° Longitude: -95.9192°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 699 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		0.0	Approximately 6" Topsoil **LEAN CLAY (CL)**, brown, reddish brown and olive brown, very stiff to hard				18	7-8-9 N=17		9.7		35-20-15	
							18	10-14-17 N=31		7.1			
		3.5	695.5										
2			**SANDSTONE+**, olive brown and brown, poorly cemented				18	13-30-40 N=70		5.5			
		5.0	694	5									
			SANDSTONE+, brown, well cemented				1	50/1"		12.7			
		8.5	690.5										
			SHALE+, sandstone seams, gray, soft to hard				9	38-50/3"		9.7			
				10									
							3	50/3"		8.8			
				15									
		18.7	680.3				2	50/2"		8.3			
			Boring Terminated at 18.7 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-34

Location: See Exploration Plan

Latitude: 36.2704° Longitude: -95.9175°

Depth (Ft.) Elevation: 699 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **SILTY LEAN CLAY (CL-ML)**, brown and olive brown, very stiff			18	7-8-9 N=17		6.2		29-22-7	
		2.0 697									
2		**SANDSTONE+**, olive brown and brown, poorly cemented to cemented			18	14-27-38 N=65		5.0			
					11	42-50/5"		3.6			
					3	50/3"		5.8			
		8.5 690.5									
		SANDSTONE+, brown, well cemented			2	50/2"		8.3			
					1	50/1"		9.0			
		18.5 680.5									
		18.6 **SANDSTONE+**, gray, well cemented 680.4			1	50/1"		8.0			
		Boring Terminated at 18.6 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-35

Location: See Exploration Plan

Latitude: 36.2704° Longitude: -95.9161°

Depth (Ft.) Elevation: 685 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2		Approximately 6" Dozed **SANDSTONE+**, olive brown, poorly cemented to cemented			16	7-31-50/2"		11.7			
					5	50/5"		9.8			
					3	50/3"		5.3			
		5			0	50/0"		8.1			
					3	50/3"		7.0			
		10									
		13.5 671.5									
		SANDSTONE+, gray, cemented			3	50/3"		6.0			
		15									
		18.8 666.2			3	50/3"		6.0			
		Boring Terminated at 18.8 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller

Logged by

Boring Started
11-07-2024

Boring Completed
11-07-2024

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-36

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 36.2707° Longitude: 95.9143° Depth (Ft.) Elevation: 683 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Dozed **CLAYEY SAND (SC)**, brown and olive brown, dense				18	3-10-23 N=33		15.1			
		2.5 680.5				8	27-50/2"		12.3			
2		**SANDSTONE+**, brown and olive brown, cemented to well cemented				4	50/4"		8.1			
			5			1	50/1"		8.1			
						3	50/3"		7.2			
			10			4	50/4"		10.3			
			15									
		18.5 664.5										
		18.9 **SHALE+**, gray, soft 664.1				5	50/5"		6.6			
		Boring Terminated at 18.9 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-11-2024

Boring Completed
11-11-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-37

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 36.2708° Longitude: -95.9130° Depth (Ft.) Elevation: 683 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Dozed **LEAN CLAY (CL)**, brown, olive brown and gray, medium stiff				18	2-1-4 N=5		9.4		28-18-10	
		2.0 681										
2		**SANDSTONE+**, brown and olive brown, cemented to well cemented				6	50/6"		10.8			
						3	50/3"		4.0			
			5			2	50/3"		5.2			
						12	27-50/6"		9.4			
			10									
						2	50/2"		7.7			
			15									
		18.5 664.5 18.7 **SHALE+**, gray, hard 664.3				2	50/2"		6.2			
		Boring Terminated at 18.7 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-11-2024

Boring Completed
11-11-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-38

Location: See Exploration Plan

Latitude: 36.2708° Longitude: -95.9115°

Depth (Ft.) Elevation: 641 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **SHALEY LEAN CLAY (CL)**, brown and olive brown, very stiff to hard			18	7-17-22 N=39		8.5		43-18-25	
					18	17-17-17 N=34		9.9			
					18	11-12-11 N=23		15.0			
		5			18	11-13-17 N=30		15.2			
					18	12-23-36 N=59		12.8			
		10									
		13.5 627.5									
2		**SHALE+**, olive brown and gray, soft			5	50/5"		13.0			
		15									
		19.0 622			6	50/6"		10.1			
		Boring Terminated at 19 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-11-2024

Boring Completed
11-11-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-39

Location: See Exploration Plan

Latitude: 36.2708° Longitude: -95.9098°

Depth (Ft.) Elevation: 641 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil									
1		**SHALEY LEAN CLAY (CL)**, brown, reddish brown and gray, very stiff to hard			18	7-8-9 N=17		11.4		36-16-20	
					18	9-10-11 N=21		12.0			
					18	8-13-18 N=31		12.9		33-16-17	
		5.0 636									
2		**SHALE+**, brown, olive brown and gray, soft			18	20-27-28 N=55		8.8			
					12	20-50/6"		14.5			
		13.5 627.5									
		SHALE+, gray, soft to hard			6	50/6"		8.7			
		18.7 622.3			2	50/2"		6.8			
		Boring Terminated at 18.7 Feet									

Depth (Ft.): 5, 10, 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
WA

Boring Started
11-11-2024

Boring Completed
11-11-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-40

Location: See Exploration Plan

Latitude: 36.2696° Longitude: -95.9192°

Depth (Ft.) Elevation: 696 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **LEAN CLAY (CL)**, with sand, brown, olive brown and reddish brown, very stiff			18	5-7-9 N=16		7.3			
					18	8-12-14 N=26		6.5		31-19-12	
2		**SANDSTONE+**, brown and olive brown, poorly cemented to cemented			10	30-50/4"		8.0			
					6	50/6"		8.2			
					3	50/3"		8.7			
		SANDSTONE+, brown, well cemented			2	50/2"		13.5			
		SANDSTONE+, gray, well cemented			2	50/2"		7.6			

3.5 692.5
13.5 682.5
18.5 677.5
18.7 677.3

Boring Terminated at 18.7 Feet

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-41

Location: See Exploration Plan

Latitude: 36.2696° Longitude: -95.9176°

Depth (Ft.) Elevation: 699 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **LEAN CLAY (CL)**, with sand, brown and olive brown, stiff to very stiff									
		3.5 695.5			18	4-5-7 N=12		5.2			
					18	11-11-13 N=24		7.8		32-21-11	
2		**SANDSTONE+**, brown and olive brown, poorly cemented			18	14-15-16 N=31		7.1			
					18	13-15-20 N=35		13.3			
		8.5 690.5									
		SANDSTONE+, brown, well cemented			2	50/2"		8.3			
		13.5 685.5									
		SANDSTONE+, brown and olive brown, cemented			3	50/3"		9.4			
		18.5 680.5									
		18.8 **SANDSTONE+**, gray, cemented 680.2			3	50/3"		8.1			
		Boring Terminated at 18.8 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-42

Location: See Exploration Plan

Latitude: 36.2695° Longitude: -95.9160°

Depth (Ft.) Elevation: 693 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2		Approximately 6" Topsoil **SANDSTONE+**, brown and olive brown, poorly cemented to cemented			10	8-12-18 N=30		5.0			
						17-35-50/4"		5.6			
						50/3"		4.8			
		5				50/4"		6.8			
						50/3"		7.7			
		10.0 683 ***Auger Refusal on sandstone at 10 Feet***									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-28-2024

Boring Completed
10-28-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-43

Location: See Exploration Plan

Latitude: 36.2696° Longitude: -95.9144°

Depth (Ft.) Elevation: 698 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2		Apporximately 6" Topsoil **SANDSTONE+**, olive brown, poorly cemented to cemented			11	4-7-10 N=17		7.4			
					8	7-9-13 N=22		7.6			
		5			13	9-12-17 N=29		11.6			
					12	9-19-32 N=51		7.9			
					10	50/4"		8.8			
		10			7	50/3"		7.5			
		15									
		18.6 679.4			5	50/1"		7.8			
		Boring Terminated at 18.6 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-28-2024

Boring Completed
10-28-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-44

Location: See Exploration Plan

Latitude: 36.2696° Longitude: -95.9130°

Depth (Ft.) Elevation: 679 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2		Approximately 6" Dozed **SANDSTONE+**, brown and olive brown, poorly cemented to cemented			10	13-39-50/3"		3.5			
					5	25-50/2"		3.3			
					6	50/4"		3.5			
		5			11	9-50/4"		4.2			
		13.5 665.5			9	50/6"		8.1			
		10									
		SHALE+, sandstone seams, gray, soft to moderately hard 14.5 664.5			10	24-50/3"		7.0			
		Auger Refusal on hard shale at 14.5 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-28-2024

Boring Completed
10-28-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-45

Location: See Exploration Plan

Latitude: 36.2696° Longitude: -95.9115°

Depth (Ft.) Elevation: 648 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Dozed **SHALEY LEAN CLAY (CL)**, gray and olive brown, very stiff			12	6-7-8 N=15		7.9			
					13	8-10-13 N=23		9.8			
					11	4-13-11 N=24		7.2			
		5			12	13-15-12 N=27		7.3			
					13	6-10-14 N=24		10.2		35-18-17	
		10									
		14.0 634			14	10-50/5"		10.1			
2		**SHALE+**, olive brown and gray, soft to hard									
		15									
		18.7 629.3			8	50/2"		8.7			
		Boring Terminated at 18.7 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-28-2024

Boring Completed
10-28-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-46

Location: See Exploration Plan

Latitude: 36.2696° Longitude: -95.9100°

Depth (Ft.) Elevation: 631 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Dozed **SHALEY LEAN CLAY (CL)**, brown, very stiff			10	7-7-9 N=16		7.0			
					8	8-12-14 N=26		8.6		33-17-16	
					9	8-11-12 N=23		11.6			
					12	6-14-14 N=28		9.0			
		8.5 622.5									
2		**SHALE+**, brown and olive brown, soft			10	7-18-22 N=40		11.5			
					12	14-50/5"		13.0			
		18.9 612.1			12	50/5"		9.7			
		Boring Terminated at 18.9 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-28-2024

Boring Completed
10-28-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-47

Location: See Exploration Plan

Latitude: 36.2696° Longitude: -95.9085°

Depth (Ft.) Elevation: 630 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil **LEAN CLAY (CL)**, with sand, brown, olive brown and gray, stiff to very stiff									
					18	2-5-7 N=12		13.6		37-19-18	
					18	12-14-14 N=28		11.6			81
					18	13-13-13 N=26		13.7			
		5.0 625									
1		**SHALEY LEAN CLAY (CL)**, brown, olive brown and gray, hard			18	14-10-21 N=31		13.0			
					18	14-21-21 N=42		13.0			
					15	17-31-50/3"		12.0			
		14.5 615.5									
2		**SHALE+**, gray, moderately hard									
					3	50/3"		6.7			
		18.8 611.2									
		Boring Terminated at 18.8 Feet									

10

15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by

Boring Started
11-07-2024

Boring Completed
11-07-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-48

Location: See Exploration Plan

Latitude: 36.2688° Longitude: -95.9192°

Depth (Ft.) Elevation: 706 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2		Approximately 6" Topsoil **SANDSTONE+**, brown and olive brown, poorly cemented to well cemented			18	10-21-22 N=43		11.2			
					18	20-23-27 N=50		6.9			
					9	30-50/3"		5.1			
		5			1	50/1"					
					3	50/3"		9.3			
		10									
					3	50/3"		8.8			
		15									
		18.7 687.3			2	50/2"		11.3			
		Boring Terminated at 18.7 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-49

Location: See Exploration Plan

Latitude: 36.2688° Longitude: -95.9176°

Depth (Ft.) Elevation: 702 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **CLAYEY SAND (SC)**, with sandstone seams, brown and olive brown, medium dense to dense			10	7-12-12 N=24		6.0			
					8	7-12-21 N=33		7.3		29-18-11	
		3.5 698.5									
		SANDSTONE+, brown and reddish brown, poorly cemented to cemented			12	15-22-46 N=68		7.5			
					12	30-50/5"		9.2			
		8.5 693.5									
2		**SHALE+**, sandstone seams, brown and olive brown, soft to hard			9	50/6"		10.4			
					10	27-50/1"		9.6			
		18.5 683.5									
		18.6 **SHALE+**, gray, hard 683.4			1	50/1"		11.6			
		Boring Terminated at 18.6 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-25-2024

Boring Completed
10-25-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-50

Location: See Exploration Plan

Latitude: 36.2688° Longitude: -95.9161°

Depth (Ft.) Elevation: 704 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **CLAYEY SAND (SC)**, with sandstone seams, brown and olive brown, medium dense			8	7-8-9 N=17		5.8			
					10	9-11-12 N=23		5.8			
3.5		700.5									
2		**SANDSTONE+**, brown and olive brown, poorly cemented to well cemented			10	50/5"		3.2			
					7	48-50/1"		4.9			
					5	50/5"		5.8			
13.5		690.5									
		SHALE+, with sandstone seams, brown, olive brown and gray, hard			2	50/2		8.7			
18.6		685.4									
		Boring Terminated at 18.6 Feet			1	50/1"		10.1			

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-25-2024

Boring Completed
10-25-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-51

Location: See Exploration Plan

Latitude: 36.2687° Longitude: -95.9144°

Depth (Ft.) Elevation: 694 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Dozed **CLAYEY SAND (SC)**, brown, medium dense to dense			8	5-4-6 N=10		5.6			
					7	7-14-21 N=35		9.0			
		4.0 690			10	21-50/4"		8.7			
2		**SHALE+**, sandstone seams, brown and olive brown, soft to moderately hard			5	50/5"		5.5			
					8	50/4"		6.2			
					6	50/5"		6.9			
		18.5 675.5									
		18.7 **SHALE+**, sandstone seams, brown and gray, hard 675.3			8	50/2"		7.9			
		Boring Terminated at 18.7 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-25-2024

Boring Completed
10-25-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-52

Location: See Exploration Plan

Latitude: 36.2687° Longitude: -95.9130°

Depth (Ft.) Elevation: 658 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2		Approximately 6" Topsoil **SANDSTONE+**, brown, poorly cemented to well cemented			14	7-12-21 N=33		7.5			
					14	7-20-25 N=45					
					10	8-50/4"		3.6			
		5			1	50/1"					
					1	50/1"		4.3			
		10									
					1	50/1"		6.6			
		15									
		18.5 639.5 18.6 639.4 **SANDSTONE+**, gray, well cemented ***Boring Terminated at 18.6 Feet***			1	50/1"		6.6			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-25-2024

Boring Completed
10-25-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-53

Location: See Exploration Plan

Latitude: 36.2687° Longitude: -95.9115°

Depth (Ft.) Elevation: 636 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil									
1		**LEAN CLAY (CL)**, with sandstone seams, brown and olive brown, stiff to very stiff			8	4-7-8 N=15		9.9		36-19-17	
					9	4-6-8 N=14		9.5			
					12	7-11-14 N=25		10.0			
		5.0 631									
2		**SANDSTONE+**, shale seams, brown and olive brown, poorly cemented to cemented			10	7-30-42 N=72		7.1			
					11	28-50/5"		7.5			
					9	40-50/3"		9.0			
		18.8 617.2			4	50/4"		9.3			
		Boring Terminated at 18.8 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-54

Location: See Exploration Plan

Latitude: 36.2687° Longitude: -95.9100°

Depth (Ft.) Elevation: 631 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil									
		LEAN CLAY (CL), brown and olive brown, very stiff			10	8-8-9 N=17		11.6			
					12	7-8-9 N=17		12.1		44-19-25	
		3.5 627.5									
		LEAN CLAY (CL), brown, gray and reddish brown, stiff			10	7-6-6 N=12		12.1			
		5			11	4-4-6 N=10		25.1		34-17-17	
1					12	4-6-7 N=13		17.2			
		10									
		13.5 617.5									
		SHALEY LEAN CLAY (CL), brown, olive brown and gray, very stiff			11	6-13-15 N=28		17.2			
		15									
		18.5 612.5									
2		18.8 **SANDSTONE+**, olive brown and gray, cemented 612.2			4	50/4"		12.8			
		Boring Terminated at 18.8 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-55

Location: See Exploration Plan

Latitude: 36.2687° Longitude: -95.9084°

Depth (Ft.) Elevation: 626 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil **CLAYEY SAND (SC)**, brown and olive brown, medium dense to dense									
		3.5 622.5			3	7-13-16 N=29		9.8			
					6	8-14-17 N=31		3.9			
1		**SHALEY LEAN TO FAT CLAY (CL/CH)**, brown and olive brown, hard			10	8-14-18 N=32		11.5		48-18-30	
					4	8-14-16 N=30		10.3			
		8.5 617.5									
		FAT CLAY (CH), olive brown and gray, stiff			10	9-4-4 N=8		22.2			
		13.5 612.5									
2		**SHALE+**, gray and dark gray, soft to moderately hard			13	9-28-24 N=52		7.1			
		18.8 607.2			4	50/4"		13.8			
		Boring Terminated at 18.8 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-56

Location: See Exploration Plan

Latitude: 36.2677° Longitude: -95.9149°

Depth (Ft.) Elevation: 690 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **CLAYEY SAND (SC)**, brown and olive brown, medium dense			4	4-6-7 N=13		4.4			
					5	6-7-12 N=19		4.0			
		3.5 686.5									
2		**SANDSTONE+**, brown, cemented to well cemented			3	50/3"		13.2			
		5			3	50/3"		5.5			
					2	50/2"		7.3			
		10			1	50/1"		9.3			
		15									
		18.8 671.2			3	50/3"		8.7			
		Boring Terminated at 18.8 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-57

Location: See Exploration Plan

Latitude: 36.2677° Longitude: -95.9136°

Depth (Ft.) | Elevation: 680 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **CLAYEY SAND (SC)**, brown and olive brown, medium dense			5	5-7-12 N=19		5.8			
		2.0 678									
2		**SANDSTONE+**, brown and olive brown, poorly cemented to cemented			4	12-22-38 N=60		5.1			
					9	36-50/3"		4.1			
		5			11	38-50/5"		4.1			
					10	31-50/4"		6.7			
		10									
					4	50/4"		7.1			
		15									
		18.5 661.5									
		18.7 **SANDSTONE+**, gray, well cemented 661.3			2	50/2"		7.0			
		Boring Terminated at 18.7 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-58

Location: See Exploration Plan

Latitude: 36.2677° Longitude: -95.9123°

Depth (Ft.) Elevation: 652 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **CLAYEY SAND (SC)**, brown, medium dense to dense									
		5.0 647			6	6-10-12 N=22		8.5			
					4	10-16-15 N=31		7.6			
					4	16-20-18 N=38		6.7			
		5			7	24-25-29 N=54		6.6			
2		**SANDSTONE+**, brown and olive brown, poorly cemented to cemented									
					4	10-14-16 N=30		9.0			
		10									
					7	11-20-31 N=51		10.8			
		15									
		19.3 632.7			10	4-50/4"		9.4			
		Boring Terminated at 19.3 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-59

Location: See Exploration Plan

Latitude: 36.2676° Longitude: -95.9107°

Depth (Ft.) Elevation: 633 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **CLAYEY SAND (SC)**, brown and olive brown, medium dense									
					2	6-6-7 N=13		6.2			
					1	9-10-10 N=20		8.3			
					5	9-11-10 N=21		8.5			
		5			6	10-13-14 N=27		8.1			
					8	4-8-11 N=19		13.6			
		10									
2		13.5 619.5 **SANDSTONE+**, shale seams, brown, gray and olive brown, poorly cemented to cemented			10	12-24-42 N=66		15.0			
		15									
					10	34-50/4"		12.7			
		19.3 613.7 ***Boring Terminated at 19.3 Feet***									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-60

Location: See Exploration Plan

Latitude: 36.2675° Longitude: -95.9086°

Depth (Ft.) Elevation: 631 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **CLAYEY SAND (SC)**, brown, medium dense									
					6	5-6-7 N=13		7.0			
					10	4-8-9 N=17		9.1			
					5	3-7-10 N=17		11.6			
		5			4	12-10-16 N=26		11.1			
		8.5 622.5									
		SHALEY FAT CLAY (CH), brown, trace olive brown, very stiff			10	8-10-12 N=22		24.3		51-25-26	
		10									
		14.5 616.5									
2		**SHALE+**, gray, soft to moderately hard			10	8-12-50/5"		16.8			
		15									
		18.8 612.2			4	50/4"		8.1			
		Boring Terminated at 18.8 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-61

Location: See Exploration Plan

Latitude: 36.2666° Longitude: -95.9150°

Depth (Ft.) Elevation: 692 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **CLAYEY SAND (SC)**, brown and reddish brown, medium dense			18	7-11-17 N=28		6.6			
		2.0 690									
2		**SANDSTONE+**, brown and reddish brown, poorly cemented to cemented			10	23-50/4"		10.1			
		3.5 688.5									
		SANDSTONE+, brown and olive brown, cemented			4	50/4"		3.9			
					3	50/3"		4.1			
					3	50/3"		8.1			
					2	50/2"		6.4			
		18.5 673.5									
		18.8 **SANDSTONE+**, brown, cemented 673.2			3	50/3"		11.8			
		Boring Terminated at 18.8 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-62

Location: See Exploration Plan

Latitude: 36.2666° Longitude: -95.9135°

Depth (Ft.) Elevation: 677 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **CLAYEY SAND (SC)**, brown and olive brown, medium dense to dense									
				X	8	6-9-10 N=19		8.9			
				X	4	9-11-14 N=25		8.5			
				X	8	7-19-12 N=31		7.9			
		5		X	12	14-14-16 N=30		8.4			
		8.5 668.5									
2		**SANDSTONE+**, brown and reddish brown, poorly cemented		X	7	6-16-18 N=34		8.2			
		10									
		13.5 663.5									
1		**SHALEY LEAN CLAY (CL)**, brown, gray and reddish brown, stiff to very stiff		X	12	7-13-15 N=28		11.8			
		15									
				X	12	6-6-7 N=13		16.7			
		20.0 657									
		20 ***Boring Terminated at 20 Feet***									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-63

Location: See Exploration Plan

Latitude: 36.2666° Longitude: -95.9122°

Depth (Ft.) Elevation: 666 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil **CLAYEY SAND (SC)**, brown and olive brown, medium dense to dense									
					5	5-9-10 N=19		10.1			
					6	10-10-12 N=22		9.6			
					4	9-11-13 N=24		7.6			
		5			5	14-15-16 N=31		8.7			
		8.5 657.5									
1		**SHALEY LEAN CLAY (CL)**, brown, reddish brown and olive brown, very stiff			7	12-13-16 N=29		11.0			
		10									
					8	7-10-11 N=21		10.9			
		15									
		18.5 647.5									
		SHALEY LEAN CLAY (CL), brown, olive brown and gray, hard									
		20.0 646			11	8-18-31 N=49		13.8			
		20									
		Boring Terminated at 20 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-64

Location: See Exploration Plan

Latitude: 36.2667° Longitude: -95.9106°

Depth (Ft.) | Elevation: 648 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil									
1		**CLAYEY SAND (SC)**, brown and olive brown, medium dense			4	7-7-8 N=15		5.9			
					4	7-7-9 N=16		6.3			
		3.5 644.5									
		SHALEY LEAN CLAY (CL), brown, olive brown and gray, very stiff to hard			8	14-17-21 N=38		9.0			
					10	16-21-20 N=41		10.3			
					12	9-14-16 N=30		10.1			
		13.5 634.5									
2		**SHALE+**, brown, reddish brown and gray, soft			11	8-16-21 N=37		8.7			
		19.5 628.5			10	21-50/6"		12.3			
		Boring Terminated at 19.5 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-65

Location: See Exploration Plan

Latitude: 36.2668° Longitude: -95.9091°

Depth (Ft.) Elevation: 636 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **CLAYEY SAND (SC)**, brown and olive brown, medium dense to dense			4	7-8-11 N=19		7.9			
					5	14-16-16 N=32		7.6			
					8	16-16-18 N=34		12.3			
					10	12-13-14 N=27		12.3			
		8.5 627.5									
		SHALEY LEAN CLAY (CL), brown, reddish brown and gray, very stiff			10	7-11-19 N=30		12.7		38-19-19	
		13.5 622.5									
2		**SHALE+**, gray and dark gray, soft			12	17-50/6"		9.8			
		18.9 617.1			7	50/5"		9.2			
		Boring Terminated at 18.9 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-66

Location: See Exploration Plan

Latitude: 36.2667° Longitude: -95.9073°

Depth (Ft.) Elevation: 632 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **SHALEY LEAN CLAY (CL)**, brown, olive brown and gray, very stiff			4	10-10-12 N=22		10.7			
					6	8-12-14 N=26		9.7		35-21-14	
		3.5 628.5									
2		**SHALE+**, brown, olive brown and gray, soft			6	12-17-28 N=45		6.4			
		5			10	33-28-32 N=60		5.9			
					11	12-50/5"		11.4			
		10									
		13.5 618.5									
		SHALE+, gray and dark gray, soft to hard			11	17-50/4"		7.1			
		15									
		18.6 613.4			1	50/1"		7.3			
		Boring Terminated at 18.6 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-67

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 36.2664° Longitude: -95.9059° Depth (Ft.) Elevation: 621 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Dozed **LEAN CLAY (CL)**, brown, olive brown and gray, medium stiff 1.5 619.5										
		2.0 **SHALEY LEAN CLAY (CL)**, brown, olive brown and gray, very stiff 619				18	2-4-27 N=31		17.9			
2		**SHALE+**, sandstone seams, brown, olive brown and gray, soft to hard	5			6	50/6"		8.1			
						6	50/6"		9.7			
						2	50/2"		8.6			
		8.0 613 ***Auger Refusal on hard shale at 8 Feet***										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by

Boring Started
11-07-2024

Boring Completed
11-07-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-68

Location: See Exploration Plan

Latitude: 36.2657° Longitude: -95.9150°

Depth (Ft.) Elevation: 697 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil **SANDSTONE+**, brown and olive brown, poorly cemented									
					18	13-12-12 N=24		4.9			
					18	11-11-10 N=21		5.5			
					18	7-13-12 N=25		11.2			
		5			18	13-17-50/6"		13.6			
		6.0 691									
2		**SANDSTONE+**, reddish brown, cemented to well cemented			1	50/1"		5.8			
		10									
					1	50/1"		7.0			
		15									
		18.7 678.3			2	50/2"		10.3			
		Boring Terminated at 18.7 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-69

Location: See Exploration Plan

Latitude: 36.2656° Longitude: -95.9135°

Depth (Ft.) Elevation: 671 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil									
1		**CLAYEY SAND (SC)**, brown and olive brown, medium stiff			18	3-6-7 N=13		9.0			
		2.0 669									
		SHALEY LEAN CLAY (CL), brown and olive brown, very stiff			18	10-11-12 N=23		8.5		34-19-15	
		3.5 667.5									
2		**SHALE+**, brown, olive brown and gray, soft			18	12-20-25 N=45		9.3			
					18	13-36-29 N=65		8.7			
					18	18-29-50/6"		11.5			
		13.5 657.5									
		SHALE+, gray, soft			5	50/5"		10.7			
		18.9 652.1			5	50/5"		6.7			
		Boring Terminated at 18.9 Feet									

5 10 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-70

Location: See Exploration Plan

Latitude: 36.2657° Longitude: -95.9123°

Depth (Ft.) Elevation: 643 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil **SHALEY LEAN CLAY (CL)**, brown and olive brown, stiff									
		3.5 639.5			18	6-7-7 N=14		10.2		35-20-15	
					18	6-7-7 N=14		11.9			
		SHALEY LEAN CLAY (CL), brown, reddish brown and gray, stiff to very stiff			18	6-7-6 N=13		11.3			
		5			18	6-8-8 N=16		13.3			
1					18	9-10-12 N=22		11.2			
		10									
					18	8-8-7 N=15		10.6			
		15									
		18.5 624.5									
2		**SHALE+**, olive brown and gray, soft to moderately hard 19.3 623.7			10	22-50/4"		11.8			
		Boring Terminated at 19.3 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-71

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 36.2657° Longitude: -95.9107° Depth (Ft.) Elevation: 629 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **LEAN CLAY (CL)**, brown, reddish brown and gray, stiff to very stiff	5			18	5-7-7 N=14		12.0			
						18	3-4-4 N=8		10.1			
							4-7-7 N=14		15.2			
						18	7-8-8 N=16		16.9		37-17-20	
						18	4-8-8 N=16		11.0			
		13.5 615.5 **SHALEY LEAN CLAY (CL)**, brown, reddish brown and gray, very stiff	10			18	10-10-10 N=20		13.3			
		18.5 610.5	15									
2		**SHALE+**, gray and dark gray, soft 19.5 609.5					27-50/6"		13.7			
		Boring Terminated at 19.5 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-72

Location: See Exploration Plan

Latitude: 36.2657° Longitude: -95.9091°

Depth (Ft.) | Elevation: 621 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil									
1		**CLAYEY SAND (SC)**, brown, medium dense			4	4-10-12 N=22		7.1			
					9	6-12-15 N=27		8.8			
		3.5 617.5									
		SHALEY LEAN CLAY (CL), brown and olive brown, very stiff to hard			4	7-15-17 N=32		10.5		39-18-21	
					10	5-13-17 N=30		11.1			
		8.5 612.5									
2		**SHALE+**, brown, gray and reddish brown, soft			8	9-50/5"		11.4			
					12	4-50/6"		11.4			
		18.5 602.5									
		18.8 **SHALE+**, gray, moderately hard 602.2			11	50/4"		7.4			
		Boring Terminated at 18.8 Feet									

5 10 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
Wes

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
Dayton S.

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-73

Location: See Exploration Plan

Latitude: 36.2647° Longitude: -95.9150°

Depth (Ft.) Elevation: 672 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **LEAN CLAY (CL)**, with sandstone seams, brown and olive brown, medium stiff to very stiff			18	7-13-10 N=23		6.8			
					18	6-5-3 N=8		9.3			
					18	2-3-2 N=5		15.9			
		5			18	4-3-3 N=6		16.5			
		8.5 663.5									
		LEAN CLAY (CL), brown and olive brown, stiff			18	6-7-6 N=13		9.5			
		10									
		13.5 658.5									
2		**SANDSTONE+**, brown and olive brown, cemented			5	50/5"		11.8			
		15									
		18.8 653.2			3	50/3"		9.8			
		Boring Terminated at 18.8 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-24-2024

Boring Completed
10-24-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-74

Location: See Exploration Plan

Latitude: 36.2647° Longitude: -95.9136°

Depth (Ft.) Elevation: 654 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **LEAN CLAY (CL)**, with sandstone seams, brown, reddish brown and gray, stiff to very stiff			18	6-7-8 N=15		9.6			
					18	9-7-9 N=16		12.6			
					18	10-11-11 N=22		9.9			
		5			18	10-14-16 N=30		9.3			
		8.5 645.5									
2		**SHALE+**, olive brown and gray, soft			18	11-18-21 N=39		10.4			
		10									
					9	36-50/3"		12.2			
		15									
		18.9 635.1			5	50/5"		9.4			
		Boring Terminated at 18.9 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-75

Location: See Exploration Plan

Latitude: 36.2647° Longitude: -95.9123°

Depth (Ft.) Elevation: 638 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil **SANDY LEAN CLAY (CL)**, brown, olive brown and reddish brown, stiff									
		5.0 633		X	18	5-5-6 N=11		10.8		32-21-11	
				X	18	6-6-5 N=11		10.7			62
				X	18	5-6-7 N=13		12.4			
		LEAN CLAY (CL), brown, gray and reddish brown, very stiff		X	18	7-8-8 N=16		13.0			
1											
				X	18	7-8-9 N=17		12.3			
				X	18	7-8-9 N=17		10.7			
2		18.5 619.5 **SHALE+**, brown, olive brown and gray, soft 19.4 618.6		X	11	25-50/5"		13.1			
		Boring Terminated at 19.4 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-76

Location: See Exploration Plan

Latitude: 36.2647° Longitude: -95.9108°

Depth (Ft.) Elevation: 632 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Topsoil **LEAN CLAY (CL)**, with sand, brown and olive brown, stiff to very stiff										
				X	13	6-6-8 N=14		11.6			80
				X	18	13-9-9 N=18		11.1			
1				X	18	8-12-13 N=25		10.4			
		5		X	18	13-13-13 N=26		15.2		38-17-21	
		3.5 628.5									
		SHALEY LEAN CLAY (CL), brown, reddish brown and gray, very stiff									
		8.5 623.5									
		SHALE+, brown, olive brown and gray, soft		X	18	12-16-17 N=33		12.4			
		10									
2				X	18	10-11-11 N=22		12.3			
		15									
		18.5 613.5									
		18.8 **SHALE+**, gray and dark gray, moderately hard 613.2		X	3	50/3"		7.5			
		Boring Terminated at 18.8 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Solid Flight Auger

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-77

Location: See Exploration Plan

Latitude: 36.2647° Longitude: -95.9091°

Depth (Ft.) Elevation: 624 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **SHALEY LEAN CLAY (CL)**, brown, olive brown and gray, very stiff			18	7-8-9 N=17		16.8			
					18	10-13-11 N=24		13.2		43-19-24	
					18	10-11-13 N=24		16.3			93
					18	11-11-11 N=22		14.5			
		8.5 615.5									
		SHALEY LEAN CLAY (CL), brown, reddish brown and gray, very stiff			18	10-12-12 N=24		12.6			
		13.5 610.5									
2		**SHALE+**, brown, reddish brown and gray, soft			18	17-27-35 N=62		11.7			
		18.5 605.5									
		SHALE+, with coal fragments, gray and dark gray, soft to hard			16	8-28-50/4"		23.3			
		19.8 604.2									
		Boring Terminated at 19.8 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
TC/WA

Boring Started
10-23-2024

Boring Completed
10-23-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-78

Location: See Exploration Plan

Latitude: 36.2652° Longitude: -95.9073°

Depth (Ft.) Elevation: 624 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approximately 6" Dozed									
1		**LEAN CLAY (CL)**, brown, olive brown and gray, stiff to very stiff			18	1-3-7 N=10		21.5		42-19-23	
					18	12-10-10 N=20		11.6			
					18	8-9-9 N=18		13.8			
					18	8-10-11 N=21		11.5			
		8.5 615.5									
2		**SHALE+**, brown, olive brown and gray, soft			6	50/6"		10.8			
		13.5 610.5									
		SHALE+, gray, hard			2	50/2"		5.7			
		16.0 608									
		Auger Refusal on hard shale at 16 Feet									

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by

Boring Started
11-07-2024

Boring Completed
11-07-2024

Project Clydesdale
NWC East 76th Street North & North Sheridan Rd Avenue | Tulsa, OK
Terracon Project No. 04245081

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-79

Location: See Exploration Plan

Latitude: 36.2651° Longitude: -95.9059°

Model Layer	Graphic Log	Depth (Ft.) / Elevation: 623 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		Approximately 6" Topsoil **LEAN CLAY (CL)**, brown, olive brown and gray, soft to medium stiff				18	1-2-2 N=4		19.3		34-20-14	
		2.5 620.5										
2		**SANDSTONE+**, brown and olive brown, cemented				12	6-50/6"		11.3			
						0	50/5"		12.4			
			5			4	50/4"		7.7			
		8.5 614.5										
		SANDSTONE+, gray and olive brown, well cemented				1	50/1"		3.4			
		10.0 613	10									
		Auger Refusal on sandstone at 10 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Water Level Observations
Not encountered while drilling

Not encountered after drilling

Drill Rig
CME550/ATV

Hammer Type
Automatic

Driller
TS

Notes

Advancement Method
Hollowed Stem Auger

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by

Boring Started
11-07-2024

Boring Completed
11-07-2024

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-101

Location: See Exploration Plan

Latitude: 36.2783° Longitude: -95.9140°
Northing: 471919 Easting: 2583311

Depth (Ft.) Approximate Elevation: 693 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 692								
1		**FAT CLAY WITH SAND (CH)**, brown and tan, soft to stiff			18	0-0-3 N=3		26.0		
1					18	4-6-9 N=15		17.7	56-15-41	83.4
1		4.5 688.5			12	6-20-50/2"		19.6		
2		**SHALE**, tan, moderately hard to hard			7	39-50/1"		8.9	35-15-20	80.9
2					15	8-15-50/3"		14.2		
2		13.7 679.3			2	50/2"		12.1		
		Auger Refusal at 13.7 Feet								

5
10

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Hammer Type
Automatic

Driller
WA

Logged by
MS

Boring Started
06-17-2025

Boring Completed
06-17-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-102

Location: See Exploration Plan

Latitude: 36.2771° Longitude: -95.9140°
Northing: 471479 Easting: 2583325.695

Depth (Ft.) Approximate Elevation: 691 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		**TOPSOIL** 1.0 (690)								
1		**SILTY SAND (SM)**, brown, loose 2.5 (688.5)			18	0-2-2 N=4		25.5	NP	
2		**SANDSTONE**, tan, poorly cemented to well cemented	▽		14	10-32-50/2"		25.1		
2					5	50/5"		20.6		
2		5			1	50/1"		27.7		
2					1	50/1"		24.2		
2		10								
2					1	50/1"		12.8		
2		15								
2		18.5 (672.5)			0	50/0"				
		Boring Terminated at 18.5 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 3.5' while drilling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MS

Boring Started
06-18-2025

Boring Completed
06-18-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-103

Location: See Exploration Plan

Latitude: 36.2774° Longitude: -95.9132°
Northing: 471590.464 Easting: 2583563.946

Depth (Ft.) Approximate Elevation: 690 (Ft.)

Model Layer	Depth (Ft.)	Elevation	Material Description	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0	689	**TOPSOIL**						
1	2.5	687.5	**SHALEY LEAN CLAY WITH SAND (CL)**, brown, very stiff	18	2-7-14 N=21		22.0	33-19-14	77.2
2			**SANDSTONE**, brown and gray, poorly cemented to well cemented	11	4-50/5"		16.3		
2				3	50/3"		14.7		
2				3	50/3"		8.1		
2				2	50/2"		11.8		
2				58.5	REC: 98% RQD: 69%	4353			
2				60	REC: 100% RQD: 100%	4720			
2	22.5	667.5		56.5	REC: 94% RQD: 63%	5444			
2			**SHALE**, gray	60	REC: 100% RQD: 100%	5892			
	30.0	660	***Boring Terminated at 30 Feet***						

Depth (Ft.): 5, 10, 15, 20, 25, 30

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Hammer Type
Automatic

Driller
PH

Logged by
JP

Boring Started
06-13-2025

Boring Completed
06-13-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-105

Location: See Exploration Plan

Latitude: 36.2762° Longitude: -95.9111°
Northing: 471172.812 Easting: 2584192.389

Depth (Ft.) Approximate Elevation: 674 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0 (673)	**TOPSOIL**								
1	2.0 (672)	**SHALEY LEAN CLAY WITH SAND (CL)**, brown and gray, hard			18	2-16-32 N=48		13.5	31-21-10	84.5
2		**SHALE**, brown and gray, soft to moderately hard			6	50/6"		8.0		
2					5	50/5"		8.5		
2	5				10	35-50/4"		8.9		
2					3	50/3"		7.1		
2	10				60	REC: 100% RQD: 53%	4502			
2	15				60	REC: 100% RQD: 66%	4374			
2	20				60	REC: 100% RQD: 98%	6433			
2	25				60	REC: 100% RQD: 99%	5815			
2	30.0 (644)									
		Boring Terminated at 30 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Hammer Type
Automatic

Driller
PH

Logged by
JP

Boring Started
06-12-2025

Boring Completed
06-12-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-106

Location: See Exploration Plan

Latitude: 36.2756° Longitude: -95.9111°
Northing: 470974.95 Easting: 2584196.647

Depth (Ft.) Approximate Elevation: 662 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 661								
1		**SHALEY LEAN CLAY (CL)**, brown, very stiff to hard			18	1-6-15 N=21		19.8		
					16	7-11-22 N=33		11.0		
2		**SHALE**, brown and gray, moderately hard			3	50/3"		8.0		
		5.0 / 657								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, brown, hard			18	21-25-33 N=58		9.7	30-19-11	84.3
		8.5 / 653.5								
2		**SHALE**, brown and gray, moderately hard			3	50/3"		7.9		
					58	REC: 97% RQD: 46%	1778			
					55.5	REC: 93% RQD: 67%				
		20.0 / 642								
		Boring Terminated at 20 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Hammer Type
Automatic

Driller
PH

Logged by
JP

Boring Started
06-12-2025

Boring Completed
06-12-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 20'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-107

Location: See Exploration Plan

Latitude: 36.2758° Longitude: -95.9118°
Northing: 471019.442 Easting: 2583964.453

Depth (Ft.) Approximate Elevation: 663 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 662								
1		**LEAN CLAY (CL)**, brown, stiff to very stiff			18	1-2-11 N=13		17.5		
					18	5-9-13 N=22		14.4	32-16-16	97.7
		3.5 659.5			12	27-50/6"		8.5		
2		**SHALE**, brown and gray, soft to moderately hard			12	23-50/6"		9.3		
					3	50/3"		7.3		
					60	REC: 100% RQD: 31%	1880			
					60	REC: 100% RQD: 86%	2924			
		20.0 643								
		Boring Terminated at 20 Feet								

5
10
15
20

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Hammer Type
Automatic

Driller
PH

Logged by
JP

Boring Started
06-12-2025

Boring Completed
06-12-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 20'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-108A

Location: See Exploration Plan

Latitude: 36.2757° Longitude: -95.9126°
Northing: 470984.779 Easting: 2583753.409

Depth (Ft.) Approximate Elevation: 671 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 670								
		LEAN CLAY (CL), brown to light brown, stiff 2.0 / 669			9	2-1-10 N=11		19.9		
1		**SHALEY LEAN CLAY WITH SAND (CL)**, brown and gray, hard			15	6-21-37 N=58		9.7		
		5.0 / 666			18	16-45-47 N=92		9.3	31-20-11	75.0
		SHALE, brown and gray, soft			5	50/5"		7.5		
					5	50/5"		7.2		
2					50	REC: 100% RQD: 66%				
					60	REC: 100% RQD: 70%				
					60	REC: 100% RQD: 57%				
					60	REC: 100% RQD: 83%	6220			
		30.0 / 641			10	REC: 100% RQD: 58%				
		Boring Terminated at 30 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-27-2025

Boring Completed
06-27-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-109

Location: See Exploration Plan

Latitude: 36.2758° Longitude: -95.9132°
Northing: 471015.057 Easting: 2583560.419

Depth (Ft.) Approximate Elevation: 670 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 669								
		LEAN CLAY (CL), brown, medium stiff 2.0 / 668			9	2-2-3 N=5		16.7		
1		**SANDY SILTY CLAY (CL-ML)**, brown to light brown, very stiff to hard			12	7-13-22 N=35		12.8	26-19-7	58.5
		5.0 / 665			16	9-13-16 N=29		12.2		
		SHALE, light brown, hard			7	17-50/1"		9.1		
					7	30-50/1"		8.1		
		10.0 / 660								
2		**INTERBEDDED SANDSTONE AND SHALE**, light brown and gray			48	REC: 100% RQD: 98%				
					60	REC: 100% RQD: 51%				
					60	REC: 100% RQD: 60%				
					72	REC: 100% RQD: 65%				
		30.0 / 640								
		Boring Terminated at 30 Feet								

Depth (Ft.): 5, 10, 15, 20, 25, 30

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-27-2025

Boring Completed
06-27-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-111A

Location: See Exploration Plan

Latitude: 36.2753° Longitude: -95.9122°
Northing: 470851.699 Easting: 2583868.65

Depth (Ft.) Approximate Elevation: 657 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 656								
		LEAN CLAY (CL), brown, stiff 2.0 / 655			17	2-5-8 N=13		17.1		
1		**SHALEY LEAN CLAY (CL)**, brown, hard			13	18-31-35 N=66		12.7		
					10	5-13-18 N=31		14.0	32-16-16	86.9
		5.5 / 651.5			10	15-50/3"		9.6		
2		**SANDSTONE**, brown, poorly cemented to well cemented			9	17-34-41 N=75		11.9		
					2	16-50/1"		6.3		
		19.1 / 637.9			3	9-50/1"		4.5		
		Boring Terminated at 19.1 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
MG

Boring Started
06-25-2025

Boring Completed
06-25-2025

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-112

Location: See Exploration Plan

Latitude: 36.2753° Longitude: -95.9111°
Northing: 470843.617 Easting: 2584192.99

Depth (Ft.) Approximate Elevation: 657 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		**TOPSOIL** 1.0 (656)								
		SANDY SHALEY LEAN CLAY (CL), light brown, very stiff 2.0 (655)			16	3-9-17 N=26		16.7	39-17-22	66.4
2		**SHALE**, light brown and gray, soft to moderately hard			12	27-50/6"		10.7		
					5	50/5"		12.1		
		5			5	50/5"		16.3		
					9	26-50/3"		16.5		
		10								
					4	50/4"		10.7		
		15								
		18.8 (638.2)			3	50/3"		6.9		
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MS

Boring Started
06-16-2025

Boring Completed
06-16-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-113A

Location: See Exploration Plan

Latitude: 36.2748° Longitude: -95.9132°
Northing: 470653.741 Easting: 2583568.186

Depth (Ft.) Approximate Elevation: 665 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 664								
		LEAN CLAY (CL), brown, medium stiff 2.0 / 663			12	1-3-5 N=8		21.7		
		SHALEY LEAN CLAY (CL), brown to reddish brown, very stiff to hard			8	6-8-16 N=24		17.2		
1					7	7-10-13 N=23		12.9	31-18-13	89.8
					18	19-29-47 N=76		10.1		
		8.5 / 656.5								
		SHALE, light brown and gray, soft to hard			11	16-50/5"		10.0		
2					10	24-50/4"		9.2		
		19.1 / 645.9			7	25-50/1"		7.8		
		Boring Terminated at 19.1 Feet								

5 10 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MG

Boring Started
06-26-2025

Boring Completed
06-26-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-115A

Location: See Exploration Plan

Latitude: 36.2748° Longitude: -95.9122°
Northing: 470666.693 Easting: 2583870.468

Depth (Ft.) Approximate Elevation: 651 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 650								
1		**SHALEY LEAN CLAY (CL)**, reddish brown, very stiff to hard			10	5-7-10 N=17		16.1		
					13	7-12-24 N=36		12.3		
					13	6-8-12 N=20		12.0		
		5			15	5-7-11 N=18		11.7	32-16-16	90.1
					11	6-10-14 N=24		9.7		
		10								
					13	7-26-50/4"		11.9		
2		**SANDSTONE**, gray, poorly cemented to cemented 14.5 636.5								
		15								
		19.0 632			3	50/5"		7.4		
		Boring Terminated at 19 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MG

Boring Started
06-24-2025

Boring Completed
06-24-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-116A

Location: See Exploration Plan

Latitude: 36.2748° Longitude: -95.9117°
Northing: 470654.892 Easting: 2584022.001

Depth (Ft.) Approximate Elevation: 649 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 648								
1		**SHALEY LEAN CLAY (CL)**, brown, very stiff to hard			7	7-14-16 N=30		10.8		
					10	5-10-13 N=23		11.1		86.1
					10	8-9-15 N=24		12.6		
		5			10	7-8-9 N=17		10.8	38-24-14	
					14	8-14-22 N=36		8.8		
		10								
		14.5 / 634.5			11	8-28-50/3"		10.0		
2		**SANDSTONE**, brown, cemented to well cemented								
		15								
		18.6 / 630.4			1	50/1"		6.3		
		Boring Terminated at 18.6 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MG

Boring Started
06-24-2025

Boring Completed
06-24-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-117

Location: See Exploration Plan

Latitude: 36.2748° Longitude: -95.9111°
Northing: 470664.924 Easting: 2584188.19

Depth (Ft.) Approximate Elevation: 649 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 648								
		LEAN CLAY (CL), reddish brown to brown, medium stiff 2.0 / 647								
1		**SHALEY LEAN CLAY (CL)**, reddish brown to brown, very stiff to hard			12	2-3-4 N=7		17.6		
					10	3-7-14 N=21		13.8		
					14	5-17-22 N=39		14.5		
		5			7	3-4-32 N=36		10.1	36-18-18	98.9
		9.0 / 640								
2		**SANDSTONE**, gray, cemented to well cemented			10	14-44-50/4"		10.3		
		10								
					5	27-50/2"		7.1		
		15								
		18.8 / 630.2			5	50/3"		7.0		
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MG

Boring Started
06-23-2025

Boring Completed
06-23-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-118

Location: See Exploration Plan

Latitude: 36.2748° Longitude: -95.9105°
Northing: 470672.849 Easting: 2584356.589

Depth (Ft.) Approximate Elevation: 652 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 651								
		LEAN CLAY (CL), brown, stiff 2.0 / 650			12	4-5-8 N=13		18.7	32-20-12	97.1
1		**SHALEY LEAN CLAY (CL)**, brown, hard			12	15-18-33 N=51		11.5		
		5.0 / 647			14	4-18-36 N=54		12.7		
		SANDSTONE, brown, poorly cemented to well cemented			8	17-50/5"		10.8		
					4	23-50/4"		8.9		
2					4	16-50/1"		8.2		
		18.7 / 633.3			4	50/2"		6.5		
		Boring Terminated at 18.7 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
MG

Boring Started
06-25-2025

Boring Completed
06-25-2025

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-119

Location: See Exploration Plan

Latitude: 36.2744° Longitude: -95.9134°
Northing: 470517.317 Easting: 2583527.896

Depth (Ft.) Approximate Elevation: 660 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 659								
1		**SHALEY LEAN CLAY (CL)**, gray, very stiff to hard			11	8-8-11 N=19		10.4		
					14	13-15-25 N=40		9.5	32-16-16	87.3
					15	7-18-24 N=42		8.5		
		5.0 / 655								
2		**SANDSTONE**, gray, cemented to well cemented			7	26-50/1"		8.2		
					10	9-24-50/1"		10.1		
					6	10-50/3"		6.7		
		18.6 / 641.4								
		Boring Terminated at 18.6 Feet			1	50/1"		5.1		

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MG

Boring Started
06-25-2025

Boring Completed
06-25-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-121A

Location: See Exploration Plan

Latitude: 36.2744° Longitude: -95.9119°
Northing: 470526.282 Easting: 2583944.805

Depth (Ft.) Approximate Elevation: 650 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 649								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, brown, stiff to hard			14	12-12-16 N=28		8.7		
					6	11-12-18 N=30		9.8		
					14	5-10-10 N=20		11.1		
		5			10	6-8-9 N=17		12.4	35-14-21	74.3
					16	4-6-8 N=14		14.1		
		10								
2		**SANDSTONE**, brown, poorly cemented to well cemented			9	12-50/5"		12.1		
		15								
		13.5 / 636.5								
		18.6 / 631.4			1	50/1"		7.2		
		Boring Terminated at 18.6 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
MG

Boring Started
06-24-2025

Boring Completed
06-24-2025

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-122A

Location: See Exploration Plan

Latitude: 36.2744° Longitude: -95.9113°
Northing: 470532.383 Easting: 2584128.369

Depth (Ft.) Approximate Elevation: 645 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 644								
1		**LEAN CLAY (CL)**, brown, stiff 2.0 643			13	2-4-6 N=10				
2		**WEATHERED SANDSTONE**, brown, poorly cemented			10	11-19-34 N=53				
					10	5-21-24 N=45				
		5			13	20-24-30 N=54				
					11	8-16-27 N=43				
		10								
					8	16-19-27 N=46				
		15								
		18.5 626.5								
		SANDSTONE, brown, poorly cemented 19.4 625.6			9	5-50/5"				
		Boring Terminated at 19.4 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MG

Boring Started
06-23-2025

Boring Completed
06-23-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-123

Location: See Exploration Plan

Latitude: 36.2744° Longitude: -95.9107°
Northing: 470538.392 Easting: 2584307.615

Depth (Ft.) Approximate Elevation: 644 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 643								
1		**SHALEY LEAN CLAY (CL)**, brown and gray, stiff to hard			12	2-4-8 N=12		14.8		
					8	3-14-21 N=35		12.5	37-24-13	96.9
					15	8-24-32 N=56		11.5		
		5.0 / 639								
2		**SANDSTONE**, brown and gray, poorly cemented to well cemented			11	18-50/5"		10.8		
					11	37-50/5"		11.2		
					11	11-50/5"		10.7		
		18.6 / 625.4								
		Boring Terminated at 18.6 Feet			1	50/1"		6.3		

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MG

Boring Started
06-24-2025

Boring Completed
06-24-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-124A

Location: See Exploration Plan

Latitude: 36.2740° Longitude: -95.9110°
Northing: 470385.841 Easting: 2584217.969

Depth (Ft.) Approximate Elevation: 644 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 643								
1		**SHALEY LEAN CLAY (CL)**, brown, hard			12	15-15-19 N=34		8.1	26-18-8	98.3
					7	8-14-22 N=36		9.0		
		5.0 / 639			14	7-13-18 N=31		8.2		
2		**SANDSTONE**, brown and gray, cemented to well cemented			14	35-50/4"		11.3		
					10	40-50/1"		9.1		
					2	15-50/1"		5.3		
		18.7 / 625.3			2	50/2"		7.6		
		Boring Terminated at 18.7 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
MG

Boring Started
06-24-2025

Boring Completed
06-24-2025

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-125A

Location: See Exploration Plan

Latitude: 36.2741° Longitude: -95.9124°
Northing: 470398.935 Easting: 2583826.52

Depth (Ft.) Approximate Elevation: 647 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 646 **TOPSOIL**								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, brown, stiff to hard			10	5-8-12 N=20		8.4		
					13	13-13-13 N=26		10.7		
					9	3-8-7 N=15		9.4	36-15-21	76.0
					15	29-33-41 N=74		9.3		
		8.5 638.5								
2		**SANDSTONE**, brown and gray, poorly cemented			11	12-50/5"		11.1		
					60	REC: 100% RQD: 59%				
					60	REC: 100% RQD: 70%	7736			
		20.0 627 ***Boring Terminated at 20 Feet***								

5
10
15
20

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MG

Boring Started
06-26-2025

Boring Completed
06-26-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 20'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-126

Location: See Exploration Plan

Latitude: 36.2762° Longitude: -95.9096°
Northing: 471188.469 Easting: 2584619.95

Depth (Ft.) | Approximate Elevation: 665 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		0								
		TOPSOIL 1.0 / 664								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, brown, very stiff to hard			18	2-6-14 N=20		18.1		
		3.5 / 661.5			18	6-10-21 N=31		16.9	29-16-13	71.4
		SHALE, brown and gray, soft to moderately hard			6	50/6"		11.7		
		5			3	50/3"		7.9		
					5	50/5"		7.6		
		10			60	REC: 100% RQD: 82%				
2		15			60	REC: 100% RQD: 71%	3614			
		20			58.5	REC: 98% RQD: 93%	4918			
		25			58	REC: 97% RQD: 97%	4224			
		30.0 / 635								
		Boring Terminated at 30 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 750X ATV

Hammer Type
Automatic

Driller
PH

Logged by
JP

Boring Started
06-11-2025

Boring Completed
06-11-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-127

Location: See Exploration Plan

Latitude: 36.2762° Longitude: -95.9082°
Northing: 471201.984 Easting: 2585047.555

Depth (Ft.) Approximate Elevation: 649 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 648								
1		**LEAN CLAY (CL)**, brown, soft 2.0 / 647			18	0-0-3 N=3		36.8		
1		**SHALEY LEAN CLAY WITH SAND (CL)**, light brown, hard 3.5 / 645.5			18	12-20-24 N=44		15.4	30-16-14	81.6
2		**SHALE**, light brown and gray, soft to hard			7	37-50/1"		9.1		
		5			6	50/6"		9.8		
					5	50/5"		9.8		
		10								
					3	50/3"		6.5		
		15								
		18.8 / 630.2			3	50/3"		5.9		
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MS

Boring Started
06-17-2025

Boring Completed
06-17-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-128

Location: See Exploration Plan

Latitude: 36.2757° Longitude: -95.9074°
Northing: 471034.446 Easting: 2585260.793

Depth (Ft.) Approximate Elevation: 641 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 640								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, light brown, stiff to hard			18	0-5-8 N=13		25.8		
					14	13-25-32 N=57		15.4		
		5.0 / 636			18	18-42-50 N=92		15.0		82.5
2		**SHALE**, light brown and gray, moderately hard			5	50/3"		16.6		
					3	50/3"		9.6		
					9	22-50/3"		10.8		
		18.9 / 622.1			4	50/4"		8.7		
		Boring Terminated at 18.9 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MS

Boring Started
06-16-2025

Boring Completed
06-16-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-129

Location: See Exploration Plan

Latitude: 36.2757° Longitude: -95.9082°
Northing: 471038.068 Easting: 2585029.476

Depth (Ft.) Approximate Elevation: 651 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		0								
		1.0 650 **TOPSOIL**								
		1.5 649.5 **LEAN CLAY WITH SAND (CL)**, brown, stiff			16	1-3-8 N=11		21.0	29-18-11	72.1
2		**SHALE**, light brown and gray, soft to hard			6	50/6"		12.5		
					11	35-50/5"		7.9		
		5			7	30-50/1"		9.1		
					7	40-50/1"		10.8		
		10								
					3	50/3"		7.5		
		15								
		18.8 632.2			3	50/3"		6.3		
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-16-2025

Boring Completed
06-16-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-130

Location: See Exploration Plan

Latitude: 36.2758° Longitude: -95.9089°
Northing: 471040.193 Easting: 2584828.446

Depth (Ft.) | Approximate Elevation: 658 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 657								
1		**LEAN CLAY (CL)**, brown, soft 2.0 / 656			10	1-0-4 N=4		17.3		
1		**SHALEY LEAN CLAY (CL)**, light brown, hard 3.5 / 654.5			18	10-12-24 N=36		13.1	30-18-12	88.8
2		**SHALE**, light brown to gray, soft to hard			9	38-50/3"		13.5		
					4	50/4"				
					5	50/3"		10.1		
					11	50/5"		7.5		
		18.6 / 639.4			3	50/1"		6.3		
		Boring Terminated at 18.6 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-16-2025

Boring Completed
06-16-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-131

Location: See Exploration Plan

Latitude: 36.2757° Longitude: -95.9097°
Northing: 471018.286 Easting: 2584610.648

Depth (Ft.) Approximate Elevation: 664 (Ft.)

Model Layer	Depth (Ft.)	Description	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	1.0 / 663	**TOPSOIL**						
1	2.0 / 662	**LEAN CLAY WITH SAND (CL)**, stiff	18	2-4-6 N=10		23.7	41-17-24	77.0
1	3.5 / 660.5	**SHALEY LEAN CLAY WITH SAND (CL)**, brown, very stiff	18	4-8-14 N=22		15.0		
2		**SHALE**, brown and gray, soft to moderately hard	6	50/6"		10.3		
2	5		5	50/5"		8.2		
2			3	50/3"		9.0		
2	10		51.5	REC: 86% RQD: 52%				
2	15		57.5	REC: 96% RQD: 63%				
2	20		54	REC: 90% RQD: 90%	1673			
2	25		60	REC: 100% RQD: 100%				
2	30.0 / 634							
		Boring Terminated at 30 Feet						

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Hammer Type
Automatic

Driller
PH

Logged by
JP

Boring Started
06-11-2025

Boring Completed
06-11-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-132

Location: See Exploration Plan

Latitude: 36.2752° Longitude: -95.9096°
Northing: 470844.22 Easting: 2584620.88

Depth (Ft.) Approximate Elevation: 660 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		**TOPSOIL** 1.0 / 659								
		SANDY SHALEY LEAN CLAY (CL), light brown, hard 2.0 / 658			14	2-13-24 N=37		17.1	30-18-12	60.0
2		**SHALE**, light brown, soft to hard			9	19-50/3"		10.4		
					3	50/3"		9.6		
		5			7	40-50/1"		10.9		
					3	50/3"		7.5		
		10								
					3	50/3"		7.5		
		15								
		19.0 / 641			6	50/6"		7.3		
		Boring Terminated at 19 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-16-2025

Boring Completed
06-16-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-133

Location: See Exploration Plan

Latitude: 36.2753° Longitude: -95.9084°
Northing: 470862.885 Easting: 2584987.867

Depth (Ft.) Approximate Elevation: 651 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 650								
1		**LEAN CLAY (CL)**, brown, soft 2.0 / 649			8	0-2-1 N=3		24.3		
		SHALEY LEAN CLAY (CL), light brown, hard 3.5 / 647.5			14	6-17-32 N=49		13.6	42-18-24	90.0
2		**SHALE**, light brown and gray, soft to hard			11	20-50/5"		9.6		
					8	32-50/2"		11.3		
					8	32-50/2"		9.7		
					3	50/3"		9.0		
		18.7 / 632.3			2	50/2"		7.2		
		Boring Terminated at 18.7 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-16-2025

Boring Completed
06-16-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-134

Location: See Exploration Plan

Latitude: 36.2753° Longitude: -95.9079°
Northing: 470865.958 Easting: 2585130.435

Depth (Ft.) Approximate Elevation: 645 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 644								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, light brown, stiff to hard			15	0-3-9 N=12		23.7		
					7	18-17-18 N=35		14.8		
					16	6-11-16 N=27		16.7	42-16-26	82.6
					14	15-29-34 N=63		10.5		
		8.5 636.5								
2		**SHALE**, light brown and gray, soft to moderately hard			11	20-50/5"		11.6		
					10	20-50/4"		10.8		
		19.0 626			6	50/6"		10.3		
		Boring Terminated at 19 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-16-2025

Boring Completed
06-16-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-135

Location: See Exploration Plan

Latitude: 36.2753° Longitude: -95.9069°
Northing: 470876.406 Easting: 2585415.476

Depth (Ft.) | Approximate Elevation: 632 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 631								
		LEAN CLAY (CL), brown, medium stiff 2.0 / 630								
1		**SHALEY LEAN CLAY (CL)**, brown, stiff to hard			15	2-2-4 N=6		17.8		
					9	2-5-8 N=13		15.1		
					14	4-8-14 N=22		18.0		
5					14	12-15-20 N=35		14.1		
		9.5 / 622.5			11	20-43-50/6"		11.6	40-24-16	98.1
2		**SHALE**, gray, soft to moderately hard								
10					1	50/3"		6.5		
15										
		18.8 / 613.2			1	50/3"		4.5		
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MG

Boring Started
06-25-2025

Boring Completed
06-25-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-136

Location: See Exploration Plan

Latitude: 36.2747° Longitude: -95.9097°
Northing: 470654.726 Easting: 2584614.155

Depth (Ft.) Approximate Elevation: 651 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	0	**TOPSOIL**								
	1.0 (650)	**SHALEY LEAN CLAY (CL)**, light brown, very stiff			16	3-8-18 N=26		13.4	31-19-12	91.9
	2.0 (649)									
2		**SHALE**, light brown and gray, soft to hard			8	21-50/2"		9.0		
					8	26-50/2"		7.7		
	5				11	28-50/5"		9.2		
					5	50/5"		8.6		
	10									
					2	50/2"		8.5		
	15									
	18.7 (632.3)				2	50/2"		5.5		
		Boring Terminated at 18.7 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-13-2025

Boring Completed
06-13-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-137

Location: See Exploration Plan

Latitude: 36.2748° Longitude: -95.9090°
Northing: 470674.109 Easting: 2584814.721

Depth (Ft.) Approximate Elevation: 654 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		**TOPSOIL** 1.0 653								
		SHALEY LEAN CLAY (CL), brown, hard 2.0 652			18	4-11-32 N=43		10.0	30-18-12	92.2
2		**SHALE**, brown and gray, soft to moderately hard			12	7-50/6"		11.6		
					4	50/4"		7.9		
		5			5	50/5"		8.6		
					6	50/6"		10.7		
		10			60	REC: 100% RQD: 45%				
		15			60	REC: 100% RQD: 73%				
		20.0 634								
		Boring Terminated at 20 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Hammer Type
Automatic

Driller
PH

Logged by
JP

Boring Started
06-11-2025

Boring Completed
06-11-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 20'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-138

Location: See Exploration Plan

Latitude: 36.2748° Longitude: -95.9084°
Northing: 470679.937 Easting: 2584985.326

Depth (Ft.) | Approximate Elevation: 650 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	0	**TOPSOIL**								
	1.0	649								
1		**SHALEY LEAN CLAY (CL)**, light brown, stiff to hard			13	2-4-9 N=13		21.8		
					18	26-37-48 N=85		10.3		
					18	8-24-47 N=71		14.7		
	5.0	645								
2	5	**SHALE**, light brown and gray, soft to hard			7	34-50/1"		11.2		
					8	26-50/2"		8.7		
	10									
					5	50/5"		7.3		
	15									
	18.8	631.2			3	50/3"		4.3		
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-13-2025

Boring Completed
06-13-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-139

Location: See Exploration Plan

Latitude: 36.2748° Longitude: -95.9079°
Northing: 470680.951 Easting: 2585132.262

Depth (Ft.) Approximate Elevation: 642 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 641								
		LEAN CLAY (CL), brown, medium stiff 2.0 / 640								
1		**SHALEY LEAN CLAY (CL)**, light brown to reddish brown, very stiff to hard			18	0-2-4 N=6		25.6		
					17	8-14-19 N=33		15.0		
					15	12-12-15 N=27		14.1		
		5			18	14-17-21 N=38		16.1		
		8.5 / 633.5								
2		**SHALE**, light brown and gray, moderately hard to hard			14	21-40-50/2"		11.6		
		10								
					9	28-50/3"		10.9		
		15								
		18.9 / 623.1			4	50/4"		8.2		
		Boring Terminated at 18.9 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-13-2025

Boring Completed
06-13-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-140

Location: See Exploration Plan

Latitude: 36.2747° Longitude: -95.9075°
Northing: 470677.385 Easting: 2585266.329

Depth (Ft.) Approximate Elevation: 638 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 637								
1		**SHALEY LEAN CLAY (CL)**, light brown, very stiff to hard			16	4-9-14 N=23		18.2		
					12	14-20-21 N=41		13.4		
					10	7-10-9 N=19		13.5		
		5			14	10-13-13 N=26		17.0	38-13-25	94.0
					14	4-8-10 N=18		14.1		
		10								
					17	9-29-44 N=73		12.7		
		15								
		18.5 619.5								
2		18.9 **SHALE**, light brown and gray, moderately hard 619.1			4	50/4"		11.3		
		Boring Terminated at 18.9 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-16-2025

Boring Completed
06-16-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-141

Location: See Exploration Plan

Latitude: 36.2747° Longitude: -95.9070°
Northing: 470673.913 Easting: 2585404.714

Depth (Ft.) Approximate Elevation: 633 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 632								
		LEAN CLAY, brown, medium stiff 2.0 / 631								
1		**SHALEY LEAN CLAY**, brown and gray, stiff to hard			18	2-2-3 N=5				
					18	4-5-9 N=14				
					18	4-8-11 N=19				
					18	5-7-11 N=18				
					18	13-28-43 N=71				
		13.5 / 619.5								
2		**SHALE**, brown and gray, moderately hard			4	50/4"				
					60	REC: 100% RQD: 71%	5033			
					60	REC: 100% RQD: 100%				
					60	REC: 100% RQD: 100%				
		30.0 / 603								
		Boring Terminated at 30 Feet								

5 10 15 20 25 30

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Hammer Type
Automatic

Driller
PM

Logged by
JP

Boring Started
06-12-2025

Boring Completed
06-12-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Wash Boring: 10' - 15'
Coring: 15' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-142

Location: See Exploration Plan

Latitude: 36.2744° Longitude: -95.9097°
Northing: 470527.834 Easting: 2584616.887

Depth (Ft.) Approximate Elevation: 646 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		**TOPSOIL** 1.0 / 645								
		SHALEY LEAN CLAY (CL), light brown, very stiff 2.0 / 644			15	4-8-14 N=22		15.5		
2		**SHALE**, light brown and gray, soft to hard			12	27-50/6"		8.5	32-21-11	90.3
					17	27-37-50/5"		10.1		
					8	34-50/2"		10.3		
					3	50/3"		9.1		
		18.9 / 627.1			4	50/4"		7.6		
		Boring Terminated at 18.9 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-13-2025

Boring Completed
06-13-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-143

Location: See Exploration Plan

Latitude: 36.2744° Longitude: -95.9089°
Northing: 470547.637 Easting: 2584836.896

Depth (Ft.) Approximate Elevation: 650 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0	**TOPSOIL**	649								
1	2.0	**SHALEY LEAN CLAY (CL)**, brown, very stiff	648			18	3-5-14 N=19		18.1		
2		**SHALE**, light brown and gray, soft to hard				10	38-50/4"		7.4		
2						16	38-40-50/4"		9.5		
2	5					13	28-49-50/1"		9.5		
2						10	31-50/4"		10.3		
2	10										
2						4	50/4"		9.1		
2	15										
2	19.0		631			5	50/5"		7.0		
		Boring Terminated at 19 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-12-2025

Boring Completed
06-12-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-144

Location: See Exploration Plan

Latitude: 36.2744° Longitude: -95.9083°
Northing: 470554.023 Easting: 2585033.423

Depth (Ft.) Approximate Elevation: 643 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (")	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 642								
		LEAN CLAY (CL), brown, medium stiff 2.0 / 641								
1		**SHALEY LEAN CLAY (CL)**, brown to light brown, very stiff to hard			16	0-2-5 N=7				
					11	11-12-13 N=25				
					13	6-9-12 N=21				
		5			18	23-28-31 N=59				
					17					
		10								
2		13.5 / 629.5 **SHALE**, light brown and gray, soft to moderately hard			5	50/5"				
		15								
		18.8 / 624.2			3	50/3"				
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-12-2025

Boring Completed
06-12-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-145

Location: See Exploration Plan

Latitude: 36.2744° Longitude: -95.9076°
Northing: 470564.802 Easting: 2585234.178

Depth (Ft.) Approximate Elevation: 637 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 636								
		LEAN CLAY (CL), brown, soft 2.0 / 635								
1		**SHALEY LEAN CLAY (CL)**, light brown, stiff to hard			18	0-0-2 N=2		22.6		
					15	6-10-11 N=21		19.5		
					7	6-7-7 N=14		12.5		
		5			12	8-7-8 N=15		17.6	45-17-28	92.6
		10			14	5-5-7 N=12		14.3		
					18	15-25-33 N=58		12.7		
		15								
2		**SHALE**, light brown and gray, soft to hard 18.5 / 618.5			11	29-50/5"		14.3		
		20								
		23.7 / 613.3			2	50/2"		8.5		
		Boring Terminated at 23.7 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-12-2025

Boring Completed
06-12-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-146

Location: See Exploration Plan

Latitude: 36.2744° Longitude: -95.9070°
Northing: 470555.811 Easting: 2585415.906

Depth (Ft.) Approximate Elevation: 632 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 631								
		FAT CLAY (CH), brown, soft 2.0 / 630								
1		**SHALEY FAT CLAY (CH)**, light brown, stiff to very stiff			12	1-2-2 N=4		21.8		
					9	5-7-7 N=14		14.9		
					8	5-5-5 N=10		14.4	50-17-33	86.8
					14	8-6-6 N=12		13.5		
					16	6-8-11 N=19		14.7		
2		**SHALE**, light brown and gray, soft 13.5 / 618.5			5	50/5"		9.7		
		19.0 / 613			5	50/5"		8.1		
		Boring Terminated at 19 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-11-2025

Boring Completed
06-12-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-147

Location: See Exploration Plan

Latitude: 36.2740° Longitude: -95.9070°
Northing: 470411.619 Easting: 2585414.692

Depth (Ft.) Approximate Elevation: 634 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 633								
		LEAN CLAY (CL), brown, soft 2.0 / 632								
1		**SHALEY LEAN CLAY (CL)**, light brown, stiff to hard			14	1-2-2 N=4				
					11	8-8-10 N=18				
					8	6-7-7 N=14				
					16	11-12-12 N=24				
					18	9-14-28 N=42				
2		**SHALE**, light brown and gray, moderately hard to hard 13.5 / 620.5			9	11-50/3"				
		18.7 / 615.3			2	50/2"				
		Boring Terminated at 18.7 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Hammer Type
Automatic

Driller
WA

Logged by
RD

Boring Started
06-11-2025

Boring Completed
06-11-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-148

Location: See Exploration Plan

Latitude: 36.2741° Longitude: -95.9081°
Northing: 470429.977 Easting: 2585068.513

Depth (Ft.) Approximate Elevation: 640 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		0 **TOPSOIL** 1.0 639								
1		**SHALEY LEAN CLAY (CL)**, brown and gray, stiff to very stiff			18	1-3-9 N=12				
					18	7-11-16 N=27		11.4		
					18	9-11-12 N=23		17.5	42-15-27	89.6
		5			18	6-8-10 N=18		16.6		
		8.5 631.5								
2		**SHALE**, brown and gray, soft			12	31-50/6"		11.9		
		10			60	REC: 100% RQD: 73%				
		15			60	REC: 100% RQD: 77%				
		20.0 620								
		20 ***Boring Terminated at 20 Feet***								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Hammer Type
Automatic

Driller
PH

Logged by
JP

Boring Started
06-11-2025

Boring Completed
06-11-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 20'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-149

Location: See Exploration Plan

Latitude: 36.2740° Longitude: -95.9096°
Northing: 470407.768 Easting: 2584636.762

Depth (Ft.) Approximate Elevation: 644 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 643								
		LEAN CLAY (CL), light brown, stiff 2.0 / 642			9	3-3-8 N=11		18.2		
1		**SHALEY LEAN CLAY (CL)**, light brown, hard 5.0 / 639			18	21-27-30 N=57		12.5	47-22-25	95.2
					18	11-21-35 N=56		16.5		
2		**SHALE**, light brown and gray, moderately hard to hard			10	21-50/4"		12.1		
					8	25-50/2"		11.2		
		13.8 / 630.2			3	50/3"		9.8		
		Boring Terminated at 13.8 Feet								

5

10

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 750X ATV

Hammer Type
Automatic

Driller
PH

Logged by
JP

Boring Started
06-13-2025

Boring Completed
06-13-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-150

Location: See Exploration Plan

Latitude: 36.2726° Longitude: -95.9074°
Northing: 469894.609 Easting: 2585287.526

Depth (Ft.) Approximate Elevation: 634 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 633								
1		**SHALEY LEAN CLAY (CL)**, light brown, stiff to hard			12	2-5-6 N=11		21.8	49-15-34	88.5
					11	7-9-8 N=17		18.2		
					21					
		5			18	8-9-10 N=19		14.7		
					11	6-7-9 N=16		13.0		
		10								
					18	14-24-49 N=73		14.3		
		15								
		20.0 614			16	6-9-24 N=33		9.5		
		Boring Terminated at 20 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 750X ATV

Hammer Type
Automatic

Driller
PH

Logged by
JP

Boring Started
06-11-2025

Boring Completed
06-11-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-151

Location: See Exploration Plan

Latitude: 36.2758° Longitude: -95.9140°
Northing: 471007.939 Easting: 2583329.336

Depth (Ft.) Approximate Elevation: 685 (Ft.)

Model Layer	Depth (Ft.)	Description	Elevation	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0	**TOPSOIL**	684									
1	2.0	**SILTY SAND (SM)**, brown and gray, medium dense	683				18	4-4-19 N=23		16.3	NP	49.2
2	5.0	**SANDSTONE**, brown, cemented	680				11	7-50/4"		17.0		
2							3	50/3"		10.2		
2		**SHALE**, brown and gray, soft to moderately hard		5			3	50/3"		8.0		
2							4	50/6"		7.5		
2				10			60	REC: 100% RQD: 61%	2430			
2				15			60	REC: 100% RQD: 63%	1924			
2				20			56.5	REC: 94% RQD: 62%	1958			
2				25			56.5	REC: 94% RQD: 84%	4663			
2	30.0		655	30								
		Boring Terminated at 30 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Hammer Type
Automatic

Driller
PH

Logged by
JP

Boring Started
06-13-2025

Boring Completed
06-13-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-152

Location: See Exploration Plan

Latitude: 36.2747° Longitude: -95.9140°
Northing: 470631.658 Easting: 2583341.744

Depth (Ft.) Approximate Elevation: 665 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 664								
1		**SHALEY LEAN CLAY (CL)**, brown, very stiff to hard			11	4-7-15 N=22		11.3		
					12	18-25-32 N=57		8.2		
		5.0 / 660			14	8-10-39 N=49		15.5	32-16-16	90.7
2		**SANDSTONE**, brown, poorly cemented to cemented			4	50/5"		7.3		
					8	15-50/3"		7.1		
					0	50/3"				
		19.0 / 646			1	50/5"		4.1		
		Boring Terminated at 19 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Hammer Type
Automatic

Driller
WA

Logged by
MG

Boring Started
06-26-2025

Boring Completed
06-26-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-156

Location: See Exploration Plan

Latitude: 36.2716° Longitude: -95.9132°
Northing: 469508.958 Easting: 2583584.52

Depth (Ft.) Elevation: 671 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 670								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, brown, very stiff to hard			18	2-7-21 N=28		20.5		
		3.5 / 667.5			18	7-13-36 N=49		16.9	30-19-11	83.2
					5	50/5"		8.9		
					4	50/4"		8.0		
					4	50/4"		9.3		
2		-gray below 15'			60	REC: 100% RQD: 53%	1377			
					58	REC: 97% RQD: 73%	3268			
					60	REC: 100% RQD: 100%	2397			
					60	REC: 100% RQD: 100%				
		30.0 / 641								
		Boring Terminated at 30 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Driller
PH

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
JP

Boring Started
06-05-2025

Boring Completed
06-05-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-157

Location: See Exploration Plan

Latitude: 36.2712° Longitude: -95.9132°
Northing: 469350.213 Easting: 2583585.889

Depth (Ft.) Elevation: 680 (Ft.)

Model Layer	Depth (Ft.)	Description	Elevation	Recovery ()	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0	**TOPSOIL**	679					
1	2.0	**SANDY SILT (ML)**, brown and gray, very stiff	678	18	3-3-13 N=16	15.4	NP	57.0
2		**SHALE**, brown and gray, soft to moderately hard		6	50/6"	8.5		
2				4	50/4"	8.4		
2	5			4	50/4"	6.4		
2		-gray below 8.5'		5	50/5"	10.1		
2	10			59	REC: 98% RQD: 98%			
2	15			59	REC: 98% RQD: 86%			
2	20			56	REC: 93% RQD: 63%			
2	25			60	REC: 100% RQD: 83%			
2	30			55	REC: 92% RQD: 88%			
2	35							

Unconfined Compressive Strength (psi)

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-05-2025

Boring Completed
06-05-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 40'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-157

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 36.2712° Longitude: -95.9132° Northing: 469350.213 Easting: 2583585.889 Depth (Ft.) Elevation: 680 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
2		**SHALE**, brown and gray, soft to moderately hard *(continued)* 40.0 640				55	REC: 92% RQD: 92%				
		Boring Terminated at 40 Feet	40								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Driller
PH

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 40'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
JP

Boring Started
06-05-2025

Boring Completed
06-05-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-158

Location: See Exploration Plan

Latitude: 36.2712° Longitude: -95.9125°
Northing: 469358.792 Easting: 2583807.077

Depth (Ft.) Elevation: 669 (Ft.)

Model Layer	Depth (Ft.)	Description	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	1.0 (668)	**TOPSOIL**								
1		**SHALEY LEAN CLAY (CL)**, brown and gray, stiff to hard			18	1-7-5 N=12		24.4		
					18	5-8-14 N=22		21.7		
					14	9-16-17 N=33		12.1	27-17-10	92.4
	5				18	15-25-34 N=59		10.8		
	8.5 (660.5)									
2		**SHALE**, brown and gray, moderately hard			9	19-50/3"		9.9		
	10				60	REC: 100% RQD: 64%	3333			
	15				60	REC: 100% RQD: 86%				
		-gray below 20'								
	20				60	REC: 100% RQD: 92%	4327			
	25				56	REC: 93% RQD: 93%	3711			
	30.0 (639)									
		Boring Terminated at 30 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-10-2025

Boring Completed
06-10-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-159

Location: See Exploration Plan

Latitude: 36.2712° Longitude: -95.9118°
Northing: 469361.043 Easting: 2584001.451

Depth (Ft.) Elevation: 658 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 657								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, light brown, very stiff to hard			18	9-10-14 N=24		11.9		
					18	6-17-20 N=37		15.3		
					18	12-16-15 N=31		14.3	39-17-22	75.1
		-brown below 5'			15	10-12-15 N=27		13.2		
					18	11-11-12 N=23		15.4		
2		**SANDSTONE**, brown, poorly cemented to cemented 13.5 / 644.5			6	50/6"		11.9		
		18.9 / 639.1			4	50/4"		9.4		
		Boring Terminated at 18.9 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers

Logged by
AG

Boring Started
06-03-2025

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Completed
06-03-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-160

Location: See Exploration Plan

Latitude: 36.2712° Longitude: -95.9110°
Northing: 469364.16 Easting: 2584234.315

Depth (Ft.) Elevation: 651 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 **TOPSOIL** 650								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, light brown to dark brown, very stiff to hard			18	5-12-20 N=32		13.0	40-14-26	81.2
					18	7-14-14 N=28		18.4		
					18	7-9-11 N=20		14.1		
		-light brown and gray below 5'			18	7-8-10 N=18		17.4		
					18	7-7-9 N=16		14.4		
					18	11-9-11 N=20		14.5		
		18.5 632.5								
2		19.1 **SANDSTONE**, light brown to dark brown, poorly cemented 631.9			6	50/6"		12.2		
		Boring Terminated at 19.1 Feet								

Depth (Ft.): 5, 10, 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
06-03-2025

Boring Completed
06-03-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-161

Location: See Exploration Plan

Latitude: 36.2717° Longitude: -95.9111°
Northing: 469537.349 Easting: 2584204.175

Depth (Ft.) Elevation: 648 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 647 **TOPSOIL**								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, brown and gray, stiff to hard			18	2-6-15 N=21		24.4		
					18	6-2-13 N=15		16.1		
					18	8-8-8 N=16		14.1		
		5			18	6-7-9 N=16		14.7		
					18	4-7-9 N=16		13.6	31-16-15	76.3
		10			10	11-19-21 N=40		17.4		
		15								
		18.5 629.5								
2		18.8 629.2 **SHALE**, gray, moderately hard			3	50/3"		12.4		
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-10-2025

Boring Completed
06-10-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Wash Boring: 10' - 20'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-162

Location: See Exploration Plan

Latitude: 36.2708° Longitude: -95.9106°
Northing: 469224.436 Easting: 2584362.196

Depth (Ft.) Elevation: 644 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	1.0 (643)	**TOPSOIL**								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, brown and gray, very stiff to hard			18	3-7-15 N=22		16.3		
					18	13-16-14 N=30		16.1		
					18	8-14-18 N=32		15.4		
	5				17	10-16-20 N=36		13.3	38-17-21	82.8
	8.5 (635.5)									
2		**SANDSTONE**, brown and gray, poorly cemented to cemented			9	23-50/3"		12.0		
	10									
					5	50/5"		9.9		
	15									
	18.8 (625.2)	-gray below 18.5'			3	50/3"		7.7		
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
06-03-2025

Boring Completed
06-03-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-163

Location: See Exploration Plan

Latitude: 36.2708° Longitude: -95.9111°
Northing: 469227.96 Easting: 2584225.962

Depth (Ft.) Elevation: 650 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 649								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, brown, very stiff to hard			18	10-15-20 N=35		14.2	36-14-22	81.2
					16	10-20-16 N=36		16.7		
					15	7-11-12 N=23		15.7		
		5			18	12-14-15 N=29		14.0		
					18	11-11-20 N=31		13.3		
		10								
		13.5 636.5								
2		**SANDSTONE**, brown and gray, poorly cemented			5	50/5"		9.0		
		15								
		19.0 631			5	50/5"		9.9		
		Boring Terminated at 19 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
06-03-2025

Boring Completed
06-03-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-164

Location: See Exploration Plan

Latitude: 36.2708° Longitude: -95.9120°
Northing: 469213.36 Easting: 2583947.477

Depth (Ft.) Elevation: 661 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 660								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, light brown and gray, hard			18	7-13-18 N=31		18.8		
					18	8-14-18 N=32		14.0	30-15-15	76.0
		5.0 656			18	14-18-22 N=40		14.1		
		SHALEY LEAN CLAY (CL), light brown and gray, hard			18	10-14-20 N=34		14.7		
		8.5 652.5			24			12.7	30-17-13	88.3
2		**SANDSTONE**, brown, poorly cemented to well cemented			6	50/6"		14.5		
					3	50/3"		7.7		
		18.7 642.3			2	50/2"		8.2		
		Boring Terminated at 18.7 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers

Logged by
AG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-03-2025

Boring Completed
06-03-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-165

Location: See Exploration Plan

Latitude: 36.2708° Longitude: -95.9126°
Northing: 469214.271 Easting: 2583789.687

Depth (Ft.) Elevation: 671 (Ft.)

Model Layer	Depth (Ft.)	Description	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0 / 670	**TOPSOIL**						
1		**SHALEY LEAN CLAY (CL/CH)**, brown and gray, very stiff	18	3-8-15 N=23		19.5		
1	3.5 / 667.5		18	4-7-14 N=21		14.4	30-20-10	85.3
2		**SHALE**, brown and gray, soft to moderately hard	12	8-50/6"		10.2		
2			9	33-50/6"		10.7		
2			4	50/4"		8.3		
2			59	REC: 98% RQD: 82%	3383			
2			55	REC: 92% RQD: 80%	1773			
2		-gray below 20'	60	REC: 100% RQD: 100%	1499			
2			60	REC: 100% RQD: 100%	3408			
2	30.0 / 641							
		Boring Terminated at 30 Feet						

Depth (Ft.): 5, 10, 15, 20, 25, 30

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-05-2025

Boring Completed
06-05-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-166

Location: See Exploration Plan

Latitude: 36.2703° Longitude: -95.9133°
Northing: 469020.632 Easting: 2583590.695

Model Layer	Depth (Ft.)	Elevation: 691 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0	**TOPSOIL** 690									
1	2.0	**SANDY SILT (ML)**, brown, hard 689				18	4-12-42 N=54		15.0	NP	58.3
		SANDSTONE, brown, cemented				4	50/4"		12.8		
						4	50/3"		11.6		
			5			4	50/4"		10.5		
	8.5	682.5		▽							
		SHALE, gray, soft to moderately hard				5	50/5"		8.7		
			10	▽							
						3	50/3"		14.1		
2			15			60	REC: 100% RQD: 95%	3412			
			20			60	REC: 100% RQD: 93%				
			25			60	REC: 100% RQD: 95%	3382			
			30			58	REC: 96% RQD: 76%	1684			
	35.0	656	35								
		Boring Terminated at 35 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 10' While drilling
▽ 8' After 24 hours

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-04-2025

Boring Completed
06-04-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Wash Boring: 10' - 15'
Coring: 15' - 35'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-167

Location: See Exploration Plan

Latitude: 36.2703° Longitude: -95.9127°
Northing: 469022.29 Easting: 2583767.88

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 676 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0	**TOPSOIL** 675									
		2.0	**LEAN CLAY (CL)**, brown, medium stiff 674				18	3-3-5 N=8		22.4		
1			**SHALEY LEAN CLAY WITH SAND (CL)**, brown, very stiff to hard				14	4-7-17 N=24		11.3	26-16-10	72.7
		5.0	671				18	10-28-6 N=34		11.1		
			SHALE, brown and gray, soft	5			11	20-50/5"		12.9		
							6	50/6"		9.9		
				10			60	REC: 100% RQD: 82%	2975			
				15			60	REC: 100% RQD: 63%	4426			
2			-gray below 20'	20			60	REC: 100% RQD: 78%				
				25			60	REC: 100% RQD: 88%	5233			
		30.0	646	30								
			Boring Terminated at 30 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-10-2025

Boring Completed
06-10-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-168

Location: See Exploration Plan

Latitude: 36.2703° Longitude: -95.9121°
Northing: 469027.832 Easting: 2583925.533

Depth (Ft.) Elevation: 663 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		0								
1		**TOPSOIL** 1.0 (662)								
		SANDY LEAN CLAY (CL), light brown, soft to medium stiff			18	2-2-3 N=5		20.1		
					18	1-1-3 N=4		21.9		
					18	2-2-3 N=5		21.7		
		5	▽							
			▽		16	1-1-1 N=2		20.8	28-17-11	64.2
					24					
		8.5 (654.5)								
2		**SANDSTONE**, light brown, poorly cemented			18	24-34-50 N=84		15.6		
		10								
					6	50/6"		15.4		
		15								
		18.9 (644.1)			5	50/5"		16.0		
		Boring Terminated at 18.9 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 5' While drilling
▽ 6' At completion of drilling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
AG

Boring Started
06-02-2025

Boring Completed
06-02-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-169

Location: See Exploration Plan

Latitude: 36.2703° Longitude: -95.9116°
Northing: 469031.178 Easting: 2584081.072

Depth (Ft.) Elevation: 653 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 652 **TOPSOIL**								
1		**LEAN CLAY WITH SAND (CL)**, brown, medium stiff to stiff			18	2-3-4 N=7		23.3		
					18	1-3-4 N=7		21.5		
					18	4-6-8 N=14		17.3		
		5			18	2-4-6 N=10		16.6	37-15-22	81.2
		8.5 644.5			23					
2		**SANDSTONE**, light brown, poorly cemented to cemented			12	15-50/6"		13.7		
		10								
		-gray below 13.5'			3	50/3"		9.8		
		15								
		18.8 634.2			3	50/3"		7.6		
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
06-02-2025

Boring Completed
06-02-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-170

Location: See Exploration Plan

Latitude: 36.2703° Longitude: -95.9111°
Northing: 469032.327 Easting: 2584234.494

Depth (Ft.) Elevation: 647 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 **TOPSOIL** 646								
1		**SHALEY LEAN CLAY (CL)**, brown and gray, very stiff to hard			18	3-9-16 N=25		17.1		
					14	5-9-17 N=26		16.4		
		5.0 642			18	8-8-25 N=33		11.1	41-25-16	99.6
2		**SHALE**, brown and gray, soft			11	29-50/5"		11.5		
					6	50/6"		10.5		
					60	REC: 100% RQD: 59%				
		-gray below 15'			60	REC: 100% RQD: 88%				
		20.0 627								
		Boring Terminated at 20 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-10-2025

Boring Completed
06-10-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 20'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-171

Location: See Exploration Plan

Latitude: 36.2703° Longitude: -95.9106°
Northing: 469039.558 Easting: 2584370.498

Depth (Ft.) Elevation: 644 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 **TOPSOIL** 643								
1		**SHALEY LEAN CLAY (CL)**, brown and gray, stiff to hard			18	6-7-8 N=15		16.3 20.0		
					18	8-16-20 N=36		15.2	43-16-27	86.3
					18	10-18-24 N=42		14.5		
		5			18	20-25-50 N=75		10.7	36-17-19	94.6
		8.5 635.5						14.0	49-16-33	
2		**SANDSTONE**, brown and gray, poorly cemented to cemented			9	32-50/3"		11.2		
		10								
		-gray below 13.5'			5	50/5"		11.4		
		15								
		18.9 625.1			4	50/4"		7.2		
		Boring Terminated at 18.9 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers

Logged by
AG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-04-2025

Boring Completed
06-04-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-172

Location: See Exploration Plan

Latitude: 36.2699° Longitude: -95.9106°
Northing: 468888.906 Easting: 2584369.418

Depth (Ft.) Elevation: 644 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 **TOPSOIL** 643								
1		**SANDY SHALEY LEAN CLAY (CL)**, brown and gray, very stiff to hard			18	4-6-11 N=17		24.6		
					18	10-18-21 N=39		13.8	41-15-26	59.4
					18	8-12-20 N=32		16.2		
		5			18	15-20-50 N=70		13.7		
		8.5 635.5								
2		**SANDSTONE**, brown and gray, poorly cemented to cemented			6	50/6"		10.7		
		10								
					5	50/5"		10.7		
		15								
		18.8 -gray below 18.5' 625.2			3	50/3"				
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers

Logged by
AG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-04-2025

Boring Completed
06-04-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-173

Location: See Exploration Plan

Latitude: 36.2699° Longitude: -95.9112°
Northing: 468896.22 Easting: 2584209.326

Depth (Ft.) Elevation: 649 (Ft.)

Model Layer	Depth (Ft.)	Elevation	Description	Recovery ()	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	1.0	648	**TOPSOIL**					
1			**SANDY LEAN CLAY (CL)**, brown and gray, soft to medium stiff	18	1-1-1 N=2	25.4		
				9	0-1-1 N=2	23.8		
				17	0-1-1 N=2	24.6	30-14-16	63.9
				16	1-2-4 N=6	30.0		
	8.5	640.5						
2			**SHALE**, brown and gray, moderately hard	15	20-31-50/3"	18.2		
	13.5	635.5						
			SANDSTONE, brown and gray, poorly cemented to well cemented -gray below 15'	5	50/5"	13.6		
	18.7	630.3						
			Boring Terminated at 18.7 Feet	2	50/2"	10.8		

Depth (Ft.): 5, 10, 15

Water Level Observations: ▽ 5' While drilling; ▽ 16' At completion of drilling

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 5' While drilling
▽ 16' At completion of drilling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
06-04-2025

Boring Completed
06-04-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-174

Location: See Exploration Plan

Latitude: 36.2700° Longitude: -95.9118°
Northing: 468922.312 Easting: 2584011.249

Depth (Ft.) Elevation: 659 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 **TOPSOIL** 658								
1		**LEAN CLAY WITH SAND (CL)**, dark brown to reddish brown, soft to medium stiff				2-3-2 N=5		19.2		
			▽			2-2-3 N=5		23.1	29-18-11	74.9
						2-2-2 N=4		20.8		
		5				1-2-2 N=4		23.7		
		8.5 650.5								
		SHALEY LEAN CLAY (CL), dark brown to reddish brown, very stiff	▽			8-9-12 N=21		18.6		
		10								
		13.5 645.5								
2		**SANDSTONE**, brown to gray, poorly cemented				50/6"		13.3		
		15								
		19.0 640				50/5"		15.7		
		Boring Terminated at 19 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 3.5' While Drilling
▽ 10' At completion of drilling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
05-30-2025

Boring Completed
05-30-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-175

Location: See Exploration Plan

Latitude: 36.2700° Longitude: -95.9126°
Northing: 468920.501 Easting: 2583784.525

Depth (Ft.) Elevation: 673 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 672 **TOPSOIL**								
1		**SHALEY LEAN CLAY (CL)**, dark gray, very stiff to hard				3-8-13 N=21		18.3	35-18-17	95.4
						5-15-15 N=30		24.6		
						9-15-32 N=47		18.6		
						10-38-50 N=88		16.9		
		8.5 664.5								
2		**SANDSTONE**, dark gray to gray, poorly cemented to well cemented				50/6"		7.9		
						50/3"		7.8		
						50/3"		6.1		
						50/3"		3.6		
		28.7 644.3				50/2"		2.9		
		Boring Terminated at 28.7 Feet								

Depth (Ft.): 5, 10, 15, 20, 25

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Logged by
MG

Boring Started
05-30-2025

Boring Completed
05-30-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-176

Location: See Exploration Plan

Latitude: 36.2699° Longitude: -95.9133°
Northing: 468878.339 Easting: 2583572.459

Depth (Ft.) Elevation: 691 (Ft.)

Model Layer	Depth (Ft.)	Elevation	Description	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0	690	**TOPSOIL**						
1	2.0	689	**SILTY SAND (SM)**, brown, very dense	18	13-14-50 N=64		14.4	NP	37.8
2	8.5	682.5	**SANDSTONE**, brown, cemented to well cemented	2	50/2"		12.8		
2				1	50/1"		4.3		
2				3	50/3"		9.5		
2				2	50/2"		10.0		
2				1	50/1"		12.6		
2			**SHALE**, gray, hard	57	REC: 95% RQD: 52%	2252			
2				60	REC: 100% RQD: 54%				
2				60	REC: 100% RQD: 73%	3003			
2				59	REC: 98% RQD: 71%	3203			

Depth (Ft.): 5, 10, 15, 20, 25, 30, 35

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'
4' After 24 hours

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-04-2025

Boring Completed
06-04-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Wash Boring: 10' - 15'
Coring: 15' - 40'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-176

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 36.2699° Longitude: -95.9133° Northing: 468878.339 Easting: 2583572.459 Depth (Ft.) Elevation: 691 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
2		**SHALE**, gray, hard *(continued)* 40.0 651				60	REC: 100% REC: 90%	2289			
		Boring Terminated at 40 Feet	40								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'
4' After 24 hours

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-04-2025

Boring Completed
06-04-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Wash Boring: 10' - 15'
Coring: 15' - 40'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-177

Location: See Exploration Plan

Latitude: 36.2696° Longitude: -95.9122°
Northing: 468757.573 Easting: 2583903.6

Depth (Ft.) Elevation: 665 (Ft.)

Model Layer	Depth (Ft.)	Elevation	Material Description	Field Test Results	Water Content (%)
1	1.0	664	**TOPSOIL**		
1	1.0 – 5.0	664 – 660	**LEAN CLAY (CL)**, reddish brown and gray, medium stiff to stiff	3-2-3 N=5	21.6
1				2-4-6 N=10	23.0
1				3-4-5 N=9	20.5
1	5.0 – 8.5	660 – 656.5	**SHALEY LEAN CLAY (CL)**, reddish brown and gray, very stiff	3-6-13 N=19	19.2
2	8.5 – 28.8	656.5 – 636.2	**SANDSTONE**, dark brown and gray, poorly cemented to cemented	50/5"	8.5
2				50/5"	18.1
2				50/3"	7.4
2				50/3"	4.5
2	28.8	636.2		50/3"	4.7
			Boring Terminated at 28.8 Feet		

Water Level Observations: Groundwater not encountered during drilling and sampling

Unconfined Compressive Strength (psi): —

Atterberg Limits (LL-PL-PI): —

Percent Fines: —

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
05-30-2025

Boring Completed
05-30-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-178

Location: See Exploration Plan

Latitude: 36.2695° Longitude: -95.9111°
Northing: 468748.23 Easting: 2584231.962

Depth (Ft.) Elevation: 652 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 **TOPSOIL** 651								
1		**SHALEY LEAN CLAY (CL)**, brown and gray, hard			18	5-11-22 N=33		21.2		
					18	22-25-17 N=42		16.1		
					18	10-17-20 N=37		15.5		
		5			18	18-18-15 N=33		11.2		
					18	21-28-38 N=66		13.3	43-22-21	99.0
		10								
2		13.5 638.5 **SHALE**, brown and gray, soft			6	50/6"		11.2		
		15								
		18.5 633.5 18.8 **SANDSTONE**, gray, cemented 633.2			3	50/3"		6.2		
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
06-04-2025

Boring Completed
06-04-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-179

Location: See Exploration Plan

Latitude: 36.2695° Longitude: -95.9106°
Northing: 468762.333 Easting: 2584387.272

Depth (Ft.) Elevation: 645 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 **TOPSOIL** 644								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, brown and gray, very stiff to hard			18	6-18-13 N=31		19.0		
					16	5-12-21 N=33		19.8		
					18	8-11-18 N=29		17.4		81.0
		5			18	11-12-13 N=25		11.8		
					18	8-9-10 N=19		13.7		
		10								
		13.5 631.5								
2		**SHALE**, brown and gray, soft			11	22-50/5"		14.2		
		15								
		18.5 626.5								
		19.1 **SANDSTONE**, brown and gray, poorly cemented 625.9			5	50/5"		12.7		
		Boring Terminated at 19.1 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
06-04-2025

Boring Completed
06-04-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-180

Location: See Exploration Plan

Latitude: 36.2690° Longitude: -95.9076°
Northing: 468577.152 Easting: 2585281.345

Depth (Ft.) Elevation: 625 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 624								
		LEAN CLAY WITH SAND (CL), dark brown, stiff			17	2-5-5 N=10		24.5		
		3.5 / 621.5			7	3-4-5 N=9		24.9	44-18-26	83.3
1		**SHALEY LEAN CLAY (CL)**, dark brown and gray, stiff to hard			18	5-6-7 N=13		23.5		
		5			18	5-8-10 N=18		18.6		
		10			18	19-33-50 N=83		12.5		
		13.5 / 611.5								
2		**SANDSTONE**, gray, cemented			3	50/3"		6.1		
		15								
		18.8 / 606.2			3	50/3"		5.9		
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
06-05-2025

Boring Completed
06-05-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-181

Location: See Exploration Plan

Latitude: 36.2702° Longitude: -95.9141°
Northing: 468991.308 Easting: 2583348.016

Depth (Ft.) | Elevation: 692 (Ft.)

Model Layer	Depth (Ft.)	Elevation	Material Description	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0	691	**TOPSOIL**						
	2.0	690	**SILTY SAND (SM)**, brown, medium dense	18	3-5-14 N=19		17.7	NP	33.4
				12	6-11-50/3"		19.3		
				4	50/4"		12.3		
				2	50/2"		18.8		
				0	50/1"				
2	13.5	678.5	**SHALE**, gray, moderately hard	2	50/3"		13.0		
				60	REC: 100% RQD: 89%	4583			
				60	REC: 100% RQD: 90%	468			
				60	REC: 100% RQD: 96%				
	30.0	662	***Boring Terminated at 30 Feet***						

Depth (Ft.): 5, 10, 15, 20, 25, 30

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-03-2025

Boring Completed
06-03-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Wash Boring: 10' - 15'
Coring: 15' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-182

Location: See Exploration Plan

Latitude: 36.2691° Longitude: -95.9140°
Northing: 468594.257 Easting: 2583369.144

Depth (Ft.) Elevation: 698 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		1.0 **TOPSOIL** 697								
		2.0 **LEAN CLAY (CL)**, dark brown, medium stiff 696				4-4-4 N=8		21.1		
2		**SANDSTONE**, reddish brown and gray, poorly cemented to well cemented				28-50/3"		13.6		
			▽			50/4"		10.7		
		5				50/5"		18.5		
						50/2"		7.4		
		10								
						50/4"		14.5		
		15	▽							
		18.9 679.1				50/4"		9.9		
		Boring Terminated at 18.9 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 3.5' While Drilling
▽ 16' At completion of drilling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
05-30-2025

Boring Completed
05-30-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-183

Location: See Exploration Plan

Latitude: 36.2706° Longitude: -95.9152°
Northing: 469129.612 Easting: 2583018.191

Depth (Ft.) Elevation: 671 (Ft.)

Model Layer	Depth (Ft.)	Description	Elevation	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0	**TOPSOIL**	670								
1	2.0	**SILTY SAND (SM)**, brown, dense	669			18	5-13-33 N=46		15.9	NP	37.4
2		**SHALE**, brown, soft to hard				5	50/5"		13.8		
2						4	50/4"		10.8		
2	5					9	30-50/2"		12.4		
2						6	50/6"		9.6		
2	10										
2		-gray below 13.5'				4	50/4"		7.2		
2	15										
2	18.8		652.2			3	50/3"		6.5		
		Boring Terminated at 18.8 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-11-2025

Boring Completed
06-11-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-184

Location: See Exploration Plan

Latitude: 36.2700° Longitude: -95.9151°
Northing: 468890.222 Easting: 2583048.751

Depth (Ft.) Elevation: 694 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		1.0 **TOPSOIL** 693								
2		**SANDSTONE**, brown and gray, poorly cemented to well cemented			6	50/6"		11.5		
					3	50/3"		11.4		
					2	50/2"		9.3		
		5			2	50/2"		8.5		
					2	50/2"		8.3		
		10			2	50/2"		8.7		
		15								
		18.7 675.3			2	50/2"		6.9		
		Boring Terminated at 18.7 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers

Logged by
AG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
05-30-2025

Boring Completed
05-30-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-185

Location: See Exploration Plan

Latitude: 36.2687° Longitude: -95.9151°
Northing: 468426.514 Easting: 2583058.776

Depth (Ft.) Elevation: 700 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 699								
1		**LEAN CLAY (CL)**, reddish brown and gray, medium stiff 2.0 / 698			18	1-2-6 N=8		20.5		
1		**SANDY SILT (ML)**, reddish brown and gray, hard 3.5 / 696.5			18	6-16-19 N=35		15.6	NP	38.5
2		**SANDSTONE**, dark brown, poorly cemented			6	50/6"		10.8		
					5	50/5"		10.7		
		8.5 / 691.5								
2		**SHALE**, gray, soft			11	27-50/5"		13.7		
		13.5 / 686.5	▽							
		SANDSTONE, reddish brown and gray, cemented			3	50/3"		11.4		
		18.8 / 681.2			3	50/3"		10.5		
		Boring Terminated at 18.8 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 13.5' While drilling
▽ 14' At completion of drilling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
AG

Boring Started
05-29-2025

Boring Completed
05-29-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-186

Location: See Exploration Plan

Latitude: 36.2693° Longitude: -95.9155°
Northing: 468654.931 Easting: 2582943.06

Depth (Ft.) Elevation: 692 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0 (691)	**TOPSOIL**								
		SANDSTONE, brown, poorly cemented to well cemented			15	7-42-50/3"		13.6		
					2	50/3"		9.2		
					5	50/5"		5.2		
	5				3	50/3"		10.1		
					4	50/4"		10.1		
	10									
		-gray below 13.5'			1	50/1"		14.1		
	15				60	REC: 100% RQD: 57%	4860			
	20				60	REC: 100% RQD: 25%	4664			
	24.0 (668)	***Boring Terminated at 24 Feet***								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-03-2025

Boring Completed
06-03-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Wash Boring: 10' - 14'
Coring: 14' - 24'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-187

Location: See Exploration Plan

Latitude: 36.2699° Longitude: -95.9167°
Northing: 468869.925 Easting: 2582572.61

Depth (Ft.) Elevation: 690 (Ft.)

Model Layer	Depth (Ft.)	Elevation	Material Description	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0	689	**TOPSOIL**								
1	2.0	688	**SILTY SAND (SM)**, brown, very dense			10	30-50/4"		11.2	NP	
2			**SANDSTONE**, brown, well cemented			0	50/0"				
2						2	50/2"		11.2		
2	5					1	50/1"		7.9		
2						1	50/1"		6.0		
2	10					0	50/1"				
2			-gray below 14'			60	REC: 100% RQD: 91%	5073			
2	15					34	REC: 57% RQD: 57%	3660			
2	20										
2	24.0	666	***Boring Terminated at 24 Feet***								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-03-2025

Boring Completed
06-05-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Wash Boring: 10' - 14'
Coring: 14' - 24'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-188

Location: See Exploration Plan

Latitude: 36.2692° Longitude: -95.9168°
Northing: 468905.267 Easting: 2582271.058

Depth (Ft.) Elevation: 695 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		1.0 **TOPSOIL** 694								
		2.0 **CLAYEY SAND (SC)**, gray, very dense 693			10	2-50/4"		16.9	26-16-10	49.9
2		**SANDSTONE**, brown, well cemented			2	50/2"		22.6		
					2	50/2"		9.4		
		5			1	50/1"		10.0		
					2	50/2"		10.9		
		10								
		-gray below 13.5'			2	50/2"		8.0		
		15								
		18.7 676.3	▽		2	50/2"		10.1		
		Boring Terminated at 18.7 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 18.5' While drilling
▽ 18.5' At completion of drilling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
AG

Boring Started
06-02-2025

Boring Completed
06-02-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-189

Location: See Exploration Plan

Latitude: 36.2701° Longitude: -95.9177°
Northing: 468905.267 Easting: 2582271.058

Depth (Ft.) Elevation: 700 (Ft.)

Model Layer	Depth (Ft.)	Elevation	Description	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	1.0	699	**TOPSOIL**				
1	2.0	698	**LEAN CLAY (CL)**, reddish brown and gray, medium stiff	2-3-4 N=7	19.8		
	3.5	696.5	**SANDY SILT (ML)**, reddish brown and gray, hard	4-22-38 N=60	15.2	NP	57.6
2	8.5	691.5	**SANDSTONE**, light brown, poorly cemented to well cemented	50/6"	10.8		
				50/2"	9.2		
	13.5	686.5	**SHALE**, light brown, moderately hard	10-50/4"	17.2		
			SANDSTONE, light brown, well cemented	50/1"	8.8		
	18.6	681.4	-gray below 18.5'	50/1"	9.4		
			Boring Terminated at 18.6 Feet				

Depth (Ft.): 5, 10, 15

Water Level Observations: Groundwater not encountered during drilling and sampling

Sample Type

Recovery ()

Unconfined Compressive Strength (psi)

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
05-29-2025

Boring Completed
05-29-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-190

Location: See Exploration Plan

Latitude: 36.2690° Longitude: -95.9183°
Northing: 468528.053 Easting: 2582126.892

Depth (Ft.) Elevation: 700 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		1.0 **TOPSOIL** 699								
1		**SILTY SAND (SM)**, reddish brown, medium dense to very dense			18	4-4-15 N=19		18.7	NP	39.5
1		3.5 696.5			18	7-24-50 N=74		20.1		
2		**SANDSTONE**, dark brown, poorly cemented to cemented			5	50/5"		14.3		
2		5			3	50/3"		11.5		
2					4	50/4"		8.8		
2		10								
2					3	50/3"		11.2		
2		15								
2		19.0 681			6	50/6"		10.6		
		Boring Terminated at 19 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers

Logged by
AG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
05-29-2025

Boring Completed
05-29-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-191

Location: See Exploration Plan

Latitude: 36.2688° Longitude: -95.9197°
Northing: 468423.476 Easting: 2581713.524

Depth (Ft.) Elevation: 700 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 **TOPSOIL** 699								
1		**LEAN CLAY (CL)**, brown, medium stiff to very stiff			12	2-3-5 N=8		22.7		
1					18	5-8-16 N=24		22.7		
1		3.5 696.5								
		SILT WITH SAND (ML), light brown, hard			18	5-25-39 N=64		14.0	NP	72.4
		5.0 695								
2		**SANDSTONE**, dark brown, cemented to well cemented			8	17-50/3"		21.0		
2					4	50/2"		16.1		
2			▽		3	50/3"		13.5		
2		18.6 681.4			1	50/1"		7.4		
		Boring Terminated at 18.6 Feet								

Depth (Ft.): 5, 10, 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 15' While drilling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers

Logged by
AG

Boring Started
05-29-2025

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Completed
05-29-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-192

Location: See Exploration Plan

Latitude: 36.2678° Longitude: -95.9141°
Northing: 468122.808 Easting: 2583364.296

Depth (Ft.) Approximate Elevation: 683 (Ft.)

Model Layer	Depth (Ft.)	Elevation	Description	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	1.0	682	**TOPSOIL**								
	1.5	681.5	**SANDY SILT (ML)**, brown, hard			1	6-35-50/1"		18.5	NP	50.4
2			**SHALE**, brown, moderately hard to hard			1	50/3"		23.6		
						1	50/3"		19.7		
						2	50/2"		20.9		
						1	50/1"		22.4		
						2	50/3"		19.9		
	18.8	664.2				2	50/3"		12.8		
			Boring Terminated at 18.8 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Boring Started
05-28-2025

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Completed
05-28-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-193

Location: See Exploration Plan

Latitude: 36.2670° Longitude: -95.9141°
Northing: 467816.079 Easting: 2583379.288

Depth (Ft.) Approximate Elevation: 681 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 680								
1		**SANDY LEAN CLAY (CL)**, reddish brown, soft 2.0 / 679			5	0-0-2 N=2		21.7		
1		**SILTY SAND (SM)**, reddish brown, very dense			7	6-35-50/5"		19.6		
1		5.0 / 676			17	2-15-45 N=60		24.4	NP	49.1
2		**SHALE**, reddish brown, soft to moderately hard			5	50/5"		23.7		
2					18	30-50/3"		24.9		
2					6	50/3"		20.4		
2		18.8 / 662.2			6	50/3"		26.2		
		Boring Terminated at 18.8 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
05-28-2025

Boring Completed
05-28-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-194

Location: See Exploration Plan

Latitude: 36.2668° Longitude: -95.9129°
Northing: 467737.925 Easting: 2583727.92

Depth (Ft.) Approximate Elevation: 661 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 660								
1		**SANDY LEAN CLAY (CL)**, brown, very soft to medium stiff			13	6-6-2 N=8		23.3		
					14	2-2-2 N=4		22.0		
					13	0-0-0 N=0		22.9		
		5			18	0-0-3 N=3		24.8		
					18	3-3-3 N=6		23.5		
		10								
					18	1-2-3 N=5		26.2	33-18-15	67.6
		15								
		20.0 641			18	2-3-3 N=6		24.1		
		Boring Terminated at 20 Feet 20								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Logged by
MG

Boring Started
05-28-2025

Boring Completed
05-28-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-195

Location: See Exploration Plan

Latitude: 36.2667° Longitude: -95.9115°
Northing: 467733.647 Easting: 2584132.567

Depth (Ft.) Approximate Elevation: 649 (Ft.)

Model Layer	Depth (Ft.)	Description	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	0	**TOPSOIL**								
	1.0 (648)	**LEAN CLAY WITH SAND (CL)**, brown, soft to stiff			18	1-1-3 N=4		23.2		
					18					
					18	4-4-4 N=8		22.0	37-15-22	77.3
	5				18	2-2-2 N=4		13.8		
1										
	10		▽		0	5-2-7 N=9		10.6		
					18	1-2-3 N=5		19.7		
	15									
	18.5 (630.5)				6	50/6"		16.8		
2	20	**SHALE**, brown and gray, soft								
					60	REC: 100% RQD: 25%				
	25									
					56	REC: 93% RQD: 58%				
	30.0 (619)									
		Boring Terminated at 30 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 10' While drilling

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-09-2025

Boring Completed
06-09-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 20'
Coring: 20' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-196

Location: See Exploration Plan

Latitude: 36.2662° Longitude: -95.9118°
Northing: 467543.952 Easting: 2584039.487

Depth (Ft.) Approximate Elevation: 650 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 649								
1		**SANDY LEAN CLAY (CL)**, brown, medium stiff			18	2-2-3 N=5		20.7		
		-brown and gray below 2'			15	2-3-3 N=6		24.7		
					18	2-2-3 N=5		20.1		
					15	3-3-3 N=6		19.1	37-20-17	59.0
					6	4-4-4 N=8		21.1		
					18	2-2-6 N=8		18.7		
		18.5 631.5								
		SHALEY LEAN CLAY (CL), brown and gray, hard			18	14-21-16 N=37		11.0		
		20.0 630								
		Boring Terminated at 20 Feet								

5 10 15 20

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers

Logged by
AG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-10-2025

Boring Completed
06-10-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-197

Location: See Exploration Plan

Latitude: 36.2661° Longitude: -95.9140°
Northing: 467495.667 Easting: 2583391.749

Depth (Ft.) Approximate Elevation: 686 (Ft.)

Model Layer	Depth (Ft.)	Description	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	1.0 (685)	**TOPSOIL**						
1		**SILTY SAND (SM)**, light brown, medium dense to dense, contains sandstone gravel	18	3-4-17 N=21		22.0		
			18	3-7-41 N=48		21.3	NP	40.6
	4.5 (681.5)		16	7-11-50/3"		19.7		
2		**SANDSTONE**, brown, cemented	4	50/4"		12.8		
			3	50/3"		11.0		
			44	REC: 73% RQD: 53%				
			57	REC: 95% RQD: 92%	3399			
			51	REC: 85% RQD: 73%	1573			
			60	REC: 100% RQD: 100%				
	30.0 (656)	***Boring Terminated at 30 Feet***						

Depth (Ft.): 5, 10, 15, 20, 25, 30

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
AG

Boring Started
06-06-2025

Boring Completed
06-06-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-198

Location: See Exploration Plan

Latitude: 36.2652° Longitude: -95.9140°
Northing: 467179.113 Easting: 2583411.393

Depth (Ft.) Approximate Elevation: 681 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		**TOPSOIL** 1.0 / 680								
2		**SHALE**, red, soft to hard			3	50/3"		16.2		
					2	50/2"		12.7		
					1	50/1"		10.3		
		5			1	50/1"		8.5		
					5	14-50/2"		8.8		
		10								
					4	30-50/1"		7.7		
		15								
		18.9 / 662.1			4	50/5"		8.2		
		Boring Terminated at 18.9 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-02-2025

Boring Completed
06-02-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-199

Location: See Exploration Plan

Latitude: 36.2670° Longitude: -95.9107°
Northing: 467854.909 Easting: 2584363.523

Depth (Ft.) Approximate Elevation: 643 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 642								
1		**SHALEY LEAN CLAY (CL)**, brown and gray, stiff to hard			16	2-4-7 N=11		19.6		
					18	2-4-8 N=12		11.6		
					12					
		5			18	8-10-10 N=20		21.8		
					18	6-9-10 N=19		12.5	38-15-23	86.3
		10	▽							
					18	7-10-24 N=34		23.2		
		15								
		18.5 624.5								
		SHALE, brown and gray, soft			6	50/6"		17.4		
		20			44	REC: 73% RQD: 37%				
		-gray and black below 25'								
		25			53	REC: 88% RQD: 63%				
		30.0 613								
		30								
		Boring Terminated at 30 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 10' While drilling

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-09-2025

Boring Completed
06-09-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Wash Boring: 10' - 20'
Coring: 20' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-200

Location: See Exploration Plan

Latitude: 36.2671° Longitude: -95.9101°
Northing: 467874.631 Easting: 2584532.032

Depth (Ft.) Approximate Elevation: 639 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 638								
1		**LEAN CLAY (CL)**, reddish brown, medium stiff to very stiff			18	2-2-4 N=6		20.7	47-19-28	90.4
					6	3-3-6 N=9		19.5		
					15	6-7-6 N=13		19.4		
		5			14	5-6-8 N=14		16.3		
					7	3-6-12 N=18		14.5	40-15-25	89.8
		10								
		13.5 625.5								
		SHALEY LEAN CLAY (CL), reddish brown, hard			11	6-26-36 N=62		13.2		
		15								
		18.5 620.5								
2		**SHALE**, reddish brown, hard			10	22-42-50/2"		12.3		
		19.7 619.3								
		Boring Terminated at 19.7 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Logged by
MG

Boring Started
05-29-2025

Boring Completed
05-29-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-201

Location: See Exploration Plan

Latitude: 36.2670° Longitude: -95.9094°
Northing: 467850.585 Easting: 2584750.384

Depth (Ft.) | Approximate Elevation: 635 (Ft.)

Model Layer	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	0								
1	**TOPSOIL** 1.0 (634)								
	SHALEY LEAN CLAY (CL), reddish brown, stiff to hard			13	3-4-8 N=12		17.4		
				8	3-7-11 N=18		15.3		
				8	6-11-14 N=25		18.1		
	5			16	5-7-10 N=17		14.0	47-16-31	90.1
				14	6-10-10 N=20		13.7		
	10								
				10	4-15-18 N=33		16.5		
	15								
2	18.5 (616.5)								
	18.6 (616.4) **SHALE**, reddish brown, hard			1	50/1"		14.5		
	Boring Terminated at 18.6 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
05-29-2025

Boring Completed
05-29-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-202

Location: See Exploration Plan

Latitude: 36.2670° Longitude: -95.9087°
Northing: 467867.558 Easting: 2584967.814

Depth (Ft.) Approximate Elevation: 630 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 629								
1		**SHALEY LEAN CLAY (CL)**, brown and gray, stiff to hard			17	3-5-11 N=16		16.6		
					12	11-13-17 N=30		15.3	49-18-31	87.5
					18	5-5-8 N=13		16.9		
		5			15	4-5-7 N=12		18.9		
					15	9-11-12 N=23		29.9		
		10								
		14.0 / 616			7	34-50/1"		12.5		
2		**SHALE**, gray, moderately hard to hard								
		15								
		18.9 / 611.1			2	50/4"		7.8		
		Boring Terminated at 18.9 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Logged by
MG

Boring Started
05-29-2025

Boring Completed
05-29-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-203

Location: See Exploration Plan

Latitude: 36.2670° Longitude: -95.9080°
Northing: 467859.925 Easting: 2585156.181

Depth (Ft.) | Approximate Elevation: 626 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0 625 **TOPSOIL**								
1		**LEAN CLAY (CL)**, brown, medium stiff to stiff			18	2-2-5 N=7		20.7	43-15-28	86.7
					15	3-4-5 N=9		16.6		
		5.0 621			18					
		SHALEY LEAN CLAY (CL), brown and gray, very stiff to hard			18	5-8-12 N=20		17.2		
			▽		18	10-21-45 N=66		13.9		
		13.5 612.5								
2		**SHALE**, gray, moderately hard			3	50/3"		16.5		
					60	REC: 100% RQD: 92%				
					60	REC: 100% RQD: 45%				
					59	REC: 98% RQD: 92%				
		30.0 596								
		Boring Terminated at 30 Feet								

Depth (Ft.): 5, 10, 15, 20, 25, 30

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 10' While drilling

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-10-2025

Boring Completed
06-10-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Wash Boring: 10' - 15'
Coring: 15' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-204

Location: See Exploration Plan

Latitude: 36.2666° Longitude: -95.9081°
Northing: 467724.91 Easting: 2585141.517

Depth (Ft.) | Approximate Elevation: 625 (Ft.)

Model Layer	Depth (Ft.)	Description	Water Level Observations	Sample Type	Recovery (")	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	1.0 / 624	**TOPSOIL**								
		LEAN CLAY (CL), brown, medium stiff to stiff			12	2-3-4 N=7		22.5		
					12	2-4-6 N=10		20.3		
	5.0 / 620				7	3-4-4 N=8		15.0		
1		**SANDY SHALEY LEAN CLAY (CL)**, brown, very stiff to hard			11	8-9-9 N=18		12.6		
					11	13-21-25 N=46		11.9	32-18-14	56.1
	14.0 / 611				5	42-50/1"		8.7		
2		**SHALE**, brown, moderately hard to hard								
	18.8 / 606.2				2	50/4"		7.5		
		Boring Terminated at 18.8 Feet								

Depth (Ft.): 5, 10, 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
05-30-2025

Boring Completed
05-30-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-205

Location: See Exploration Plan

Latitude: 36.2666° Longitude: -95.9086°
Northing: 467714.711 Easting: 2584982.167

Depth (Ft.) | Approximate Elevation: 629 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	1.0 / 628	**TOPSOIL**								
1		**LEAN CLAY WITH SAND (CL)**, dark brown and gray, stiff to very stiff			18	2-4-8 N=12		24.0		
					18	5-7-12 N=19		21.1		
					17	3-5-11 N=16		19.3		
	5				18	11-12-14 N=26		13.0	41-14-27	84.7
	8.5 / 620.5									
1		**SHALEY LEAN CLAY (CL)**, brown and gray, hard			18	12-17-21 N=38		10.9		
	10									
	14.0 / 615									
2		**SHALE**, brown and gray, soft			12	28-50/6"		12.0		
	15									
	18.5 / 610.5									
	18.7 / 610.3	**SANDSTONE**, gray, well cemented			2	50/2"		9.0		
		Boring Terminated at 18.7 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers

Logged by
AG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-05-2025

Boring Completed
06-05-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-206

Location: See Exploration Plan

Latitude: 36.2666° Longitude: -95.9097°
Northing: 467709.061 Easting: 2584666.582

Depth (Ft.) Approximate Elevation: 635 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 634								
		LEAN CLAY (CL), brown, medium stiff to stiff			18	2-3-4 N=7		23.5		
					6	3-4-6 N=10		18.7		
					10	3-5-6 N=11		19.7		
		5			15	3-6-9 N=15		13.4		
		8.5 626.5								
1		**SHALEY LEAN CLAY (CL)**, brown, very stiff			7	4-7-13 N=20		13.3		
		10								
					9	9-12-17 N=29		15.0	45-19-26	94.3
		15								
		18.5 616.5								
2		19.3 **SHALE**, brown, moderately hard 615.7			7	11-50/3"		12.0		
		Boring Terminated at 19.3 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Logged by
MG

Boring Started
05-29-2025

Boring Completed
05-29-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-207

Location: See Exploration Plan

Latitude: 36.2662° Longitude: -95.9107°
Northing: 467561.689 Easting: 2584369.483

Depth (Ft.) Approximate Elevation: 642 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 641								
		FAT CLAY (CH), brown, soft 2.0 / 640			18	2-1-3 N=4		22.2		
		SHALEY LEAN CLAY WITH SAND (CL), brown and gray, very stiff to hard			17					
					18	7-11-8 N=19		9.8		
					16	8-8-11 N=19		14.8	43-13-30	75.4
1					18	9-9-11 N=20		12.0		
		18.5 / 623.5								
		SHALE, brown and gray, soft			5	50/5"		17.7		
					60	REC: 100% RQD: 48%				
2					48	REC: 80% RQD: 32%	1781			
		30.0 / 612								
		Boring Terminated at 30 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
10' While drilling

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-09-2025

Boring Completed
06-09-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Wash Boring: 10' - 20'
Coring: 20' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-208

Location: See Exploration Plan

Latitude: 36.2662° Longitude: -95.9102°
Northing: 467568.876 Easting: 2584521.383

Depth (Ft.) Approximate Elevation: 638 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 637								
1		**LEAN CLAY WITH SAND (CL)**, brown, very soft to stiff			10	0-0-0 N=0		22.8		
					11	2-3-3 N=6		28.0	36-17-19	74.9
					13	0-1-3 N=4		20.3		
		-gray below 5'			18	2-4-5 N=9		19.6		
					7	3-4-7 N=11		18.3		
					14	5-7-8 N=15		12.2		
		19.0 619								
2		19.6 **SHALE**, gray, hard 618.4			9	13-37-50/1"		23.4		
		Boring Terminated at 19.6 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
05-29-2025

Boring Completed
05-29-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-209

Location: See Exploration Plan

Latitude: 36.2662° Longitude: -95.9096°
Northing: 467571.205 Easting: 2584688.071

Depth (Ft.) Approximate Elevation: 635 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 634								
		LEAN CLAY (CL), brown, medium stiff to stiff			18	2-3-4 N=7		23.5		
					18	3-5-5 N=10		22.4		
					11	4-7-8 N=15		20.9		
					14	6-5-6 N=11		13.4	44-13-31	85.9
		8.5 626.5			24					
1		**SHALEY LEAN CLAY (CL)**, brown, very stiff			10	4-7-15 N=22		12.4		
					14	7-12-15 N=27		15.3		
		19.0 616								
2		19.7 **SHALE**, brown, hard 615.3			10	4-35-50/2"		10.9		
		Boring Terminated at 19.7 Feet								

Depth (Ft.): 5, 10, 15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
05-29-2025

Boring Completed
05-29-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-210

Location: See Exploration Plan

Latitude: 36.2663° Longitude: -95.9091°
Northing: 467596.487 Easting: 2584834.5

Depth (Ft.) Approximate Elevation: 632 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 631								
		LEAN CLAY (CL), dark brown, medium stiff to stiff			13	3-3-3 N=6		27.9		
					18	3-4-5 N=9		20.5	46-14-32	85.2
					10	3-6-8 N=14		21.8		
		5.0 / 627								
1		**SHALEY LEAN CLAY (CL)**, brown and gray, very stiff			18	8-9-16 N=25		20.1		
					18	11-14-15 N=29		11.5		
		14.0 / 618								
		SANDSTONE, brown, cemented			15	13-25-50/4"		11.3		
		-gray below 18.5'			4	50/4"		8.7		
2					4	50/4"		6.7		
		28.8 / 603.2			3	50/3"		6.3		
		Boring Terminated at 28.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
06-05-2025

Boring Completed
06-05-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-211

Location: See Exploration Plan

Latitude: 36.2663° Longitude: -95.9086°
Northing: 467602.182 Easting: 2584991.916

Depth (Ft.) | Approximate Elevation: 629 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 628								
1		**LEAN CLAY (CL)**, reddish brown, medium stiff to very stiff			14	2-3-5 N=8		19.6		
					7	3-4-6 N=10		16.4 19.8	44-17-27	88.5
					8	4-8-8 N=16		14.2		
		5			10	3-6-7 N=13		12.0		
		8.5 / 620.5								
		SANDY SHALEY LEAN CLAY (CL), reddish brown, hard			8	9-19-24 N=43		8.7	34-14-20	52.2
		10								
		14.5 / 614.5			3	7-18-50/4"		14.2		
2		**SHALE**, reddish brown, moderately hard								
		15								
		18.8 / 610.2				50/4"		7.7		
		Boring Terminated at 18.8 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Logged by
MG

Boring Started
05-30-2025

Boring Completed
05-30-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-212

Location: See Exploration Plan

Latitude: 36.2663° Longitude: -95.9080°
Northing: 467584.406 Easting: 2585165.454

Depth (Ft.) Approximate Elevation: 625 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	1.0 / 624	**TOPSOIL**								
1		**LEAN CLAY (CL)**, brown, medium stiff to stiff			18	2-3-5 N=8		17.3		
					15	3-3-6 N=9		18.5		
	5.0 / 620				6	4-5-7 N=12		17.8	41-13-28	91.0
		SHALEY LEAN CLAY (CL), brown, hard			9	10-17-25 N=42		12.6		
					24					
	9.5 / 615.5				17	6-15-50/5"		17.4		
2		**SHALE**, brown, soft to hard			4	50/5"		8.7		
	19.6 / 605.4				7	30-40-50/1"		8.4		
		Boring Terminated at 19.6 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Logged by
MG

Boring Started
05-30-2025

Boring Completed
05-30-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-213

Location: See Exploration Plan

Latitude: 36.2658° Longitude: -95.9081°
Northing: 467408.528 Easting: 2585143.77

Depth (Ft.) | Approximate Elevation: 627 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 626								
		LEAN CLAY WITH SAND (CL), dark brown, medium stiff to very stiff 3.5 / 623.5			13	4-7-9 N=16		17.7		
					17	2-1-6 N=7		36.2		
1		**SHALEY LEAN CLAY WITH SAND (CL)**, dark brown and gray, very stiff to hard			18	7-10-11 N=21		18.6	49-15-34	82.4
					18	2-10-12 N=22		21.9		
					18	12-15-21 N=36		9.7		
2		**SANDSTONE**, gray, poorly cemented to well cemented 13.5 / 613.5			6	50/6"		9.2		
		18.7 / 608.3			2	50/2"		10.7		
		Boring Terminated at 18.7 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
0.5' While drilling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
06-05-2025

Boring Completed
06-05-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-214

Location: See Exploration Plan

Latitude: 36.2657° Longitude: -95.9086°
Northing: 467392.85 Easting: 2584993.616

Depth (Ft.) | Approximate Elevation: 630 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 629								
1		**LEAN CLAY (CL)**, reddish brown, soft to stiff			12	2-2-2 N=4		25.8		
					15	4-4-8 N=12		19.1		
					9	3-4-8 N=12		14.7		
		5			15	5-5-7 N=12		14.2	39-14-25	86.9
					12	4-7-8 N=15		14.5		
		10								
		13.5 / 616.5 **SHALEY LEAN CLAY (CL)**, reddish brown, hard			11	12-14-20 N=34		14.9		
		15								
2		18.5 / 611.5 18.9 / 611.1 **SHALE**, reddish brown, soft			4	50/5"		9.8		
		Boring Terminated at 18.9 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
05-30-2025

Boring Completed
05-30-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-215

Location: See Exploration Plan

Latitude: 36.2658° Longitude: -95.9096°
Northing: 467392.71 Easting: 2584715.616

Depth (Ft.) Approximate Elevation: 631 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 630								
		LEAN CLAY (CL), brown, medium stiff 2.0 / 629								
1		**SHALEY LEAN CLAY (CL)**, brown, very stiff to hard			13	0-1-4 N=5		20.3		
					15	5-11-17 N=28		14.6		
					8	5-7-13 N=20		17.0	39-15-24	88.9
					12	7-8-11 N=19		12.6		
					12	11-13-20 N=33		11.5		
		14.5 / 616.5			10	19-41-50/1"		10.7		
2		**SHALE**, brown, moderately hard to hard								
		18.9 / 612.1			3	50/3"		7.9		
		Boring Terminated at 18.9 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-02-2025

Boring Completed
06-02-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-216

Location: See Exploration Plan

Latitude: 36.2657° Longitude: -95.9102°
Northing: 467361.492 Easting: 2584525.623

Depth (Ft.) Approximate Elevation: 634 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 633								
		LEAN CLAY (CL), brown, soft to medium stiff			15	1-3-5 N=8		20.7		
					13	2-2-5 N=7		22.5		
					16	2-2-2 N=4		22.0		
		5.0 / 629								
		SHALEY LEAN CLAY (CL), brown, very stiff			18	6-6-12 N=18		15.6		
1					11	6-10-15 N=25		15.2		
					10	6-7-11 N=18		12.0	36-14-22	88.8
		18.5 / 615.5								
2		18.9 **SHALE**, brown, soft / 615.1			5	50/5"		10.1		
		Boring Terminated at 18.9 Feet								

5
10
15

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-02-2025

Boring Completed
06-02-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-217

Location: See Exploration Plan

Latitude: 36.2652° Longitude: -95.9103°
Northing: 467197.866 Easting: 2584515.72

Depth (Ft.) Approximate Elevation: 636 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 635								
1		**SHALEY FAT CLAY (CH)**, dark brown and gray, stiff to hard			14	3-8-18 N=26		22.0		
					18	8-16-19 N=35		19.2		
					17	7-7-7 N=14		12.7	53-19-34	88.3
		5			16	8-10-13 N=23		12.4		
					18	6-9-12 N=21		13.8		
		10								
					18	8-18-19 N=37		29.0		
		15								
		18.5 617.5								
2		**SHALE**, dark gray, soft			5	50/5"		16.4		
		20								
					14	REC: 23% RQD: 13%				
		25								
					44	REC: 73% RQD: 52%				
		30.0 606								
		Boring Terminated at 30 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 20'

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers: 0' - 20'
Coring: 20' - 30'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
AG

Boring Started
06-09-2025

Boring Completed
06-09-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-218

Location: See Exploration Plan

Latitude: 36.2652° Longitude: -95.9095°
Northing: 467192.833 Easting: 2584729.404

Depth (Ft.) Approximate Elevation: 633 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 632								
1		**SHALEY LEAN CLAY (CL)**, brown, medium stiff to hard			12	6-8-13 N=21		13.3		
					7	8-18-20 N=38		11.3	40-15-25	86.7
					12	4-6-6 N=12		14.4		
		5			18	3-3-4 N=7		17.0		
					8	3-5-10 N=15		14.7		
		10								
					11	7-10-11 N=21		10.5		
		15								
2		19.0 614			6	35-50/1"		10.4		
		19.1 **SHALE**, brown, hard 613.9								
		Boring Terminated at 19.1 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-03-2025

Boring Completed
06-03-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-219

Location: See Exploration Plan

Latitude: 36.2652° Longitude: -95.9087°
Northing: 467209.532 Easting: 2584958.504

Depth (Ft.) Approximate Elevation: 629 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 628								
		LEAN CLAY (CL), tan and brown, medium stiff to stiff			8	2-2-6 N=8		25.8		
					18	2-3-6 N=9		16.8		
		3.5 / 625.5								
1		**SHALEY LEAN CLAY WITH SAND (CL)**, tan and gray, very stiff			18	6-9-12 N=21		18.5		
		5			12	6-8-15 N=23		23.4		
					18	3-8-15 N=23		14.7	38-14-24	75.8
		10								
		14.0 / 615			6	30-50/3"		9.7		
2		**SHALE**, tan and gray, moderately hard to hard								
		15								
		19.1 / 609.9			6	35-50/1"		10.4		
		Boring Terminated at 19.1 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-03-2025

Boring Completed
06-03-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-220

Location: See Exploration Plan

Latitude: 36.2653° Longitude: -95.9080°
Northing: 467234.776 Easting: 2585174.313

Depth (Ft.) Approximate Elevation: 625 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (")	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 624								
		LEAN CLAY WITH SAND (CL), brown and tan, medium stiff to very stiff			10	1-3-4 N=7		24.0		
					10	4-5-7 N=12		21.9		
					10	4-5-8 N=13		20.5		
					18	5-7-11 N=18		12.8	41-15-26	71.0
		8.5 / 616.5								
1		**SHALEY LEAN CLAY (CL)**, tan and gray, very stiff to hard			6	4-7-12 N=19		13.1		
					6	11-22-42 N=64		13.6		
		18.5 / 606.5								
2		18.7 **SHALE**, gray to dark gray, hard 606.3			2	50/2"		7.9		
		Boring Terminated at 18.7 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Notes

Advancement Method
Continuous Flight Augers

Logged by
MG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-03-2025

Boring Completed
06-03-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-221

Location: See Exploration Plan

Latitude: 36.2649° Longitude: -95.9082°
Northing: 467075.999 Easting: 2585126.191

Depth (Ft.) Approximate Elevation: 627 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 626								
1		**FAT CLAY (CH)**, brown and gray, stiff			18	3-4-7 N=11		21.7		
					15	3-3-7 N=10		26.2		
		3.5 623.5								
		SHALEY FAT CLAY (CH), brown and gray, very stiff			18	9-11-12 N=23		15.3		
		5			15	5-8-13 N=21		22.3	57-20-37	89.0
		10			18	8-10-12 N=22		13.9		
		15			18	3-4-24 N=28		24.3		
		18.5 608.5								
2		**SHALE**, gray, moderately hard			4	50/4"		15.8		
		20			44	REC: 73% RQD: 67%	6696			
		25			57	REC: 95% RQD: 87%				
		30.0 597								
		30								
		Boring Terminated at 30 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 20'

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers: 0' - 20'
Coring: 20' - 30'

Logged by
AG

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-10-2025

Boring Completed
06-10-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-222

Location: See Exploration Plan

Latitude: 36.2648° Longitude: -95.9100°
Northing: 467031.959 Easting: 2584607.07

Depth (Ft.) Approximate Elevation: 634 (Ft.)

Model Layer	Depth (Ft.)	Elevation	Description	Recovery ()	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	1.0	633	**TOPSOIL**					
			LEAN CLAY WITH SAND (CL), brown, medium stiff to stiff	11	0-2-3 N=5	22.6		
				14	4-6-8 N=14	21.6		
				8	3-5-7 N=12	20.8	45-13-32	85.0
				15	2-4-7 N=11	20.8		
	8.5	625.5						
1			**SHALEY LEAN CLAY (CL)**, brown, very stiff to hard	8	4-8-12 N=20	16.4		
				10	7-10-16 N=26	11.4		
				11	6-14-26 N=40	16.3		
	20.0	614	***Boring Terminated at 20 Feet***					

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Logged by
MG

Boring Started
06-03-2025

Boring Completed
06-03-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-223

Location: See Exploration Plan

Latitude: 36.2660° Longitude: -95.9068°
Northing: 467488.024 Easting: 2585526.958

Depth (Ft.) Approximate Elevation: 620 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 619								
		LEAN CLAY (CL), brown, medium stiff 2.0 / 618								
1		**SHALEY LEAN CLAY (CL)**, brown, tan, and gray, stiff to very stiff			6	2-3-4 N=7		23.9		
					15	2-5-7 N=12		16.5	40-20-20	90.2
					15	6-8-8 N=16		16.4		
		5			18	8-13-14 N=27		12.8		
		9.0 / 611			6	24-50/1"		11.7		
2		**SHALE**, gray, hard								
		10								
					2	50/2"		6.3		
		15								
		18.7 / 601.3			2	50/2"		1.5		
		Boring Terminated at 18.7 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Logged by
MG

Boring Started
06-03-2025

Boring Completed
06-03-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-224

Location: See Exploration Plan

Latitude: 36.2680° Longitude: -95.9071°
Northing: 468219.063 Easting: 2585421.371

Depth (Ft.) Approximate Elevation: 624 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 623								
1		**FAT CLAY (CH)**, brown and gray, stiff			16	4-5-4 N=9		24.3	66-17-49	90.2
					15	2-4-6 N=10		20.1		
					18	3-5-8 N=13		19.2		
					12	3-3-7 N=10		21.5		
		8.5 / 615.5								
		SHALEY FAT CLAY (CH), brown and gray, hard 10.0 / 614			18	24-35-50 N=85		12.9		
2		**SHALE**, gray			20	REC: 33% RQD: 0%				
					6	REC: 10% RQD: 0%				
		20.0 / 604								
		Boring Terminated at 20 Feet								

5 10 15 20

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 550 ATV

Driller
RP

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 20'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
AG

Boring Started
06-10-2025

Boring Completed
06-10-2025

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-225

Location: See Exploration Plan

Latitude: 36.2684° Longitude: -95.9075°
Northing: 468363.625 Easting: 2585294.328

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 625 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		1.0	**TOPSOIL** 624									
1			**FAT CLAY (CH)**, brown, stiff to very stiff				14	2-5-7 N=12		21.2		
							18	5-7-7 N=14		19.7	59-15-44	87.8
				5			13	5-8-9 N=17		23.6		
							24 18	5-8-10 N=18		19.4		
		8.5	616.5									
			SHALEY FAT CLAY (CH), brown and gray, hard				18	15-20-27 N=47		17.0		
		13.5	611.5	10								
2			**SANDSTONE**, gray, cemented				4	50/4"		7.8		
				15								
		18.9	606.1				4	50/4"		7.6		
			Boring Terminated at 18.9 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 550 ATV

Driller
RP

Logged by
AG

Boring Started
06-05-2025

Boring Completed
06-05-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-226

Location: See Exploration Plan

Latitude: 36.2658° Longitude: -95.9118°
Northing: 467380.366 Easting: 2584059.692

Depth (Ft.) Approximate Elevation: 648 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 / 647								
		LEAN CLAY WITH SAND (CL), brown, soft to medium stiff			13	0-1-2 N=3		21.7		
					6	2-2-1 N=3		23.8		
					12	1-2-1 N=3		28.9		
		5			13	2-3-2 N=5		20.3	46-14-32	80.8
1										
					12	2-3-5 N=8		24.0		
		10								
					18	2-2-5 N=7		19.1		
		15								
		18.5 / 629.5								
		SHALEY LEAN CLAY (CL), brown, hard			14	5-27-39 N=66		15.5		
		20.0 / 628								
		20								
		Boring Terminated at 20 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered during drilling and sampling

Drill Rig
CME 55 Track

Driller
WA

Logged by
MG

Boring Started
06-02-2025

Boring Completed
06-02-2025

Notes

Advancement Method
Continuous Flight Augers

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-227

Location: See Exploration Plan

Latitude: 36.2661° Longitude: -95.9125°
Northing: 467517.089 Easting: 2583835.241

Depth (Ft.) Approximate Elevation: 658 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		TOPSOIL 1.0 657								
1		**SANDY LEAN CLAY (CL)**, brown to dark brown and gray, medium stiff			18	2-2-3 N=5		20.8		
					18	2-2-4 N=6		22.6		
					18	2-3-4 N=7		21.6		
		5			14	1-3-5 N=8		19.9		
					18	1-4-4 N=8		19.6	33-17-16	56.3
		10								
2		**CLAYEY SAND (SC)**, brown and gray, medium dense 18.5 639.5			18	7-8-15 N=23		19.9		
		SANDSTONE, brown and gray, cemented	▽		9	35-50/3"		18.2		
		15								
					50	REC: 83% RQD: 32%				
		20								
		25.0 633								
		25								
		Boring Terminated at 25 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 18.5' While drilling

Drill Rig
CME 55 Track

Driller
WA

Logged by
MG

Boring Started
06-06-2025

Boring Completed
06-06-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 20'
Coring: 20' - 25'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-228

Location: See Exploration Plan

Latitude: 36.2773° Longitude: -95.9126°
Northing: 471575.626 Easting: 2583729.214

Depth (Ft.) | Approximate Elevation: 691 (Ft.)

Model Layer	Depth (Ft.)	Elevation	Material Description	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (%)	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	0.0	691	**TOPSOIL**									
	1.0	690	**SHALEY LEAN CLAY WITH SAND (CL)**, brown and gray, very stiff to hard				10	2-6-12 N=18		15.9		
							18	7-12-23 N=35		11.5	38-18-20	77.1
	3.5	687.5	**SHALE**, brown and gray, soft to hard				6	50/6"		10.5		
				5			3	50/3"		6.4		
							2	50/2"		9.2		
2	10.0	681	**SANDSTONE**, brown and gray	10			60	REC: 100% RQD: 75%	6315			
				15			60	REC: 100% RQD: 82%	4575			
				20			55	REC: 92% RQD: 43%	6889			
	24.0	667	**SHALE**, gray	25			59.5	REC: 99% RQD: 60%				
				30								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Driller
PH

Logged by
JP

Boring Started
06-12-2025

Boring Completed
06-12-2025

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 40'

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Boring Log No. B-228

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 36.2773° Longitude: -95.9126° Northing: 471575.626 Easting: 2583729.214 Depth (Ft.) Approximate Elevation: 691 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery ()	Field Test Results	Unconfined Compressive Strength (psi)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
2		**SHALE**, gray *(continued)*	35			60	REC: 100% RQD: 78%	4475			
						60	RQD: 100% RQD: 100%	4861			
		40.0 651	40								
		Boring Terminated at 40 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Dry to 10'

Drill Rig
CME 750X ATV

Driller
PH

Notes

Advancement Method
Continuous Flight Augers: 0' - 10'
Coring: 10' - 40'

Logged by
JP

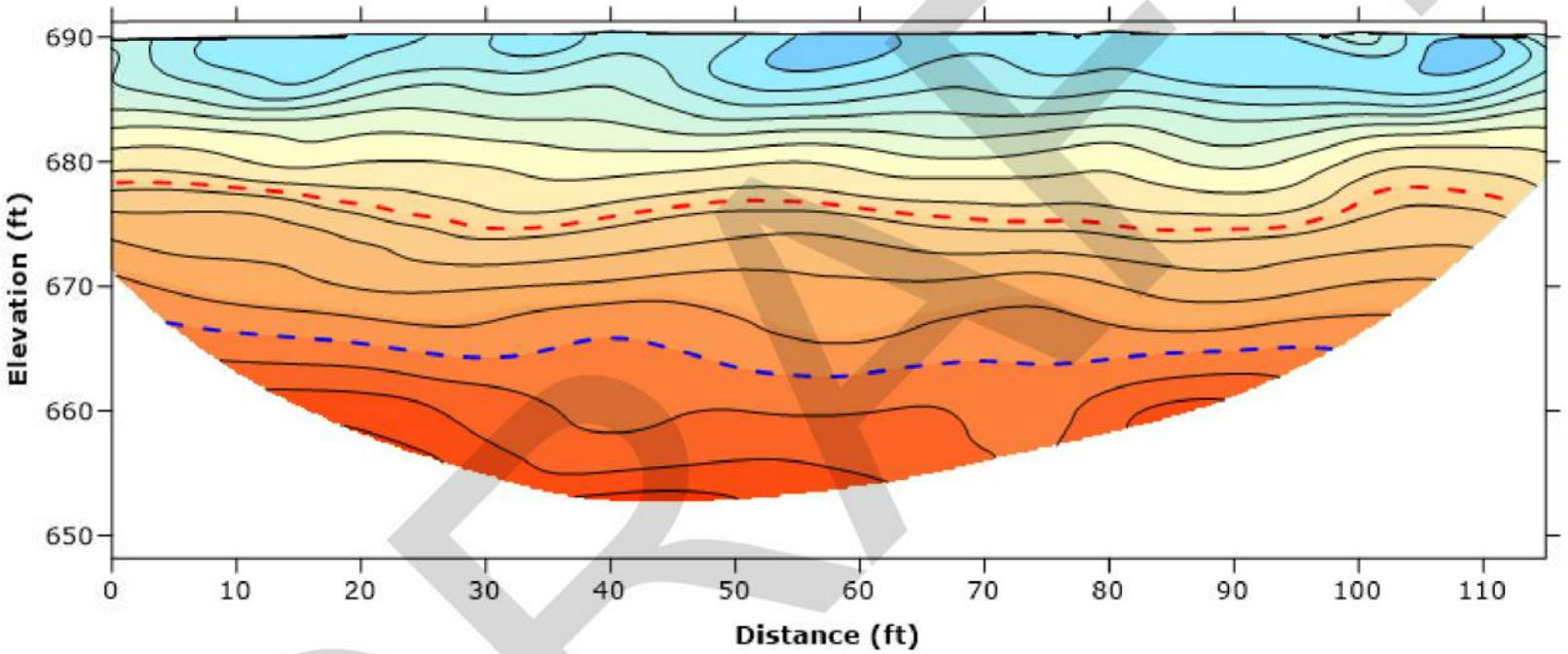
Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Boring Started
06-12-2025

Boring Completed
06-12-2025

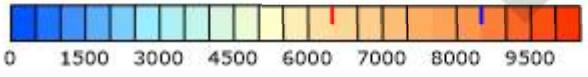
DRAFT

SR-1EW



- – – Up to 6,300 ft/s rippable with D8R/D8T
- – – Up to 8,500 ft/s marginally rippable with D8R/D8T
  Velocities over this threshold may be unrippable

P-Wave Velocity (ft/s) - CI = 1000



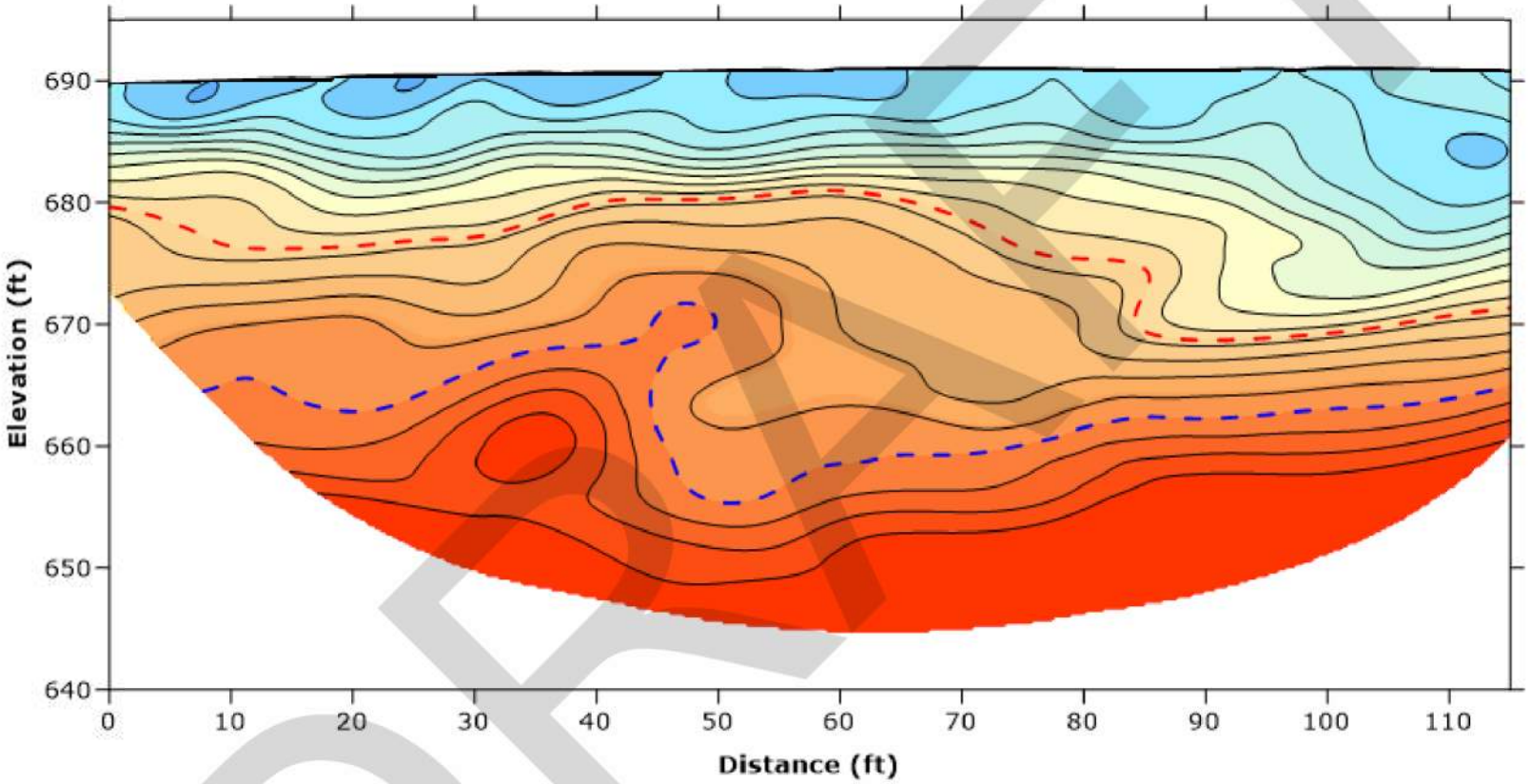
Terracon

Date: 06/2025 | Project Number: 04255087

Seismic Refraction Results - SR-1EW	Exhibit
Project Clydesdale Design Level Sperry, Oklahoma	2

DRAFT

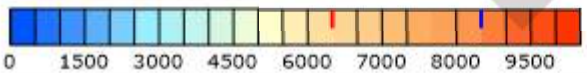
SR-1NS



- - - Up to 6,300 ft/s rippable with D8R/D8T

- - - Up to 8,500 ft/s marginally rippable with D8R/D8T
Velocities over this threshold may be unrippable

P-Wave Velocity (ft/s) - CI = 1000

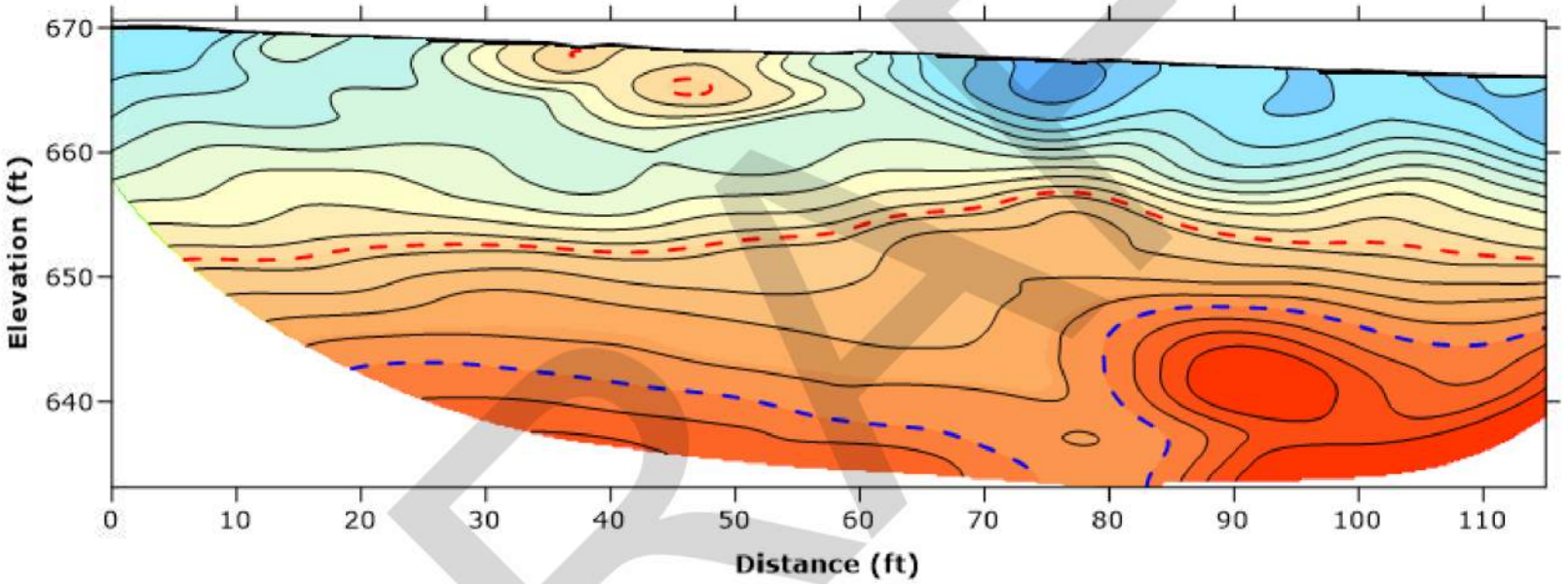


Terracon

Date: 06/2025 | Project Number: 04255087

Seismic Refraction Results - SR-1NS	Exhibit
Project Clydesdale Design Level Sperry, Oklahoma	3

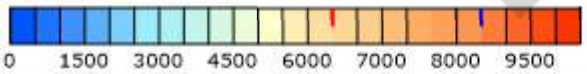
SR-2



Up to 6,300 ft/s rippable with D8R/D8T

Up to 8,500 ft/s marginally rippable with D8R/D8T
Velocities over this threshold may be unrippable

P-Wave Velocity (ft/s) - CI = 1000



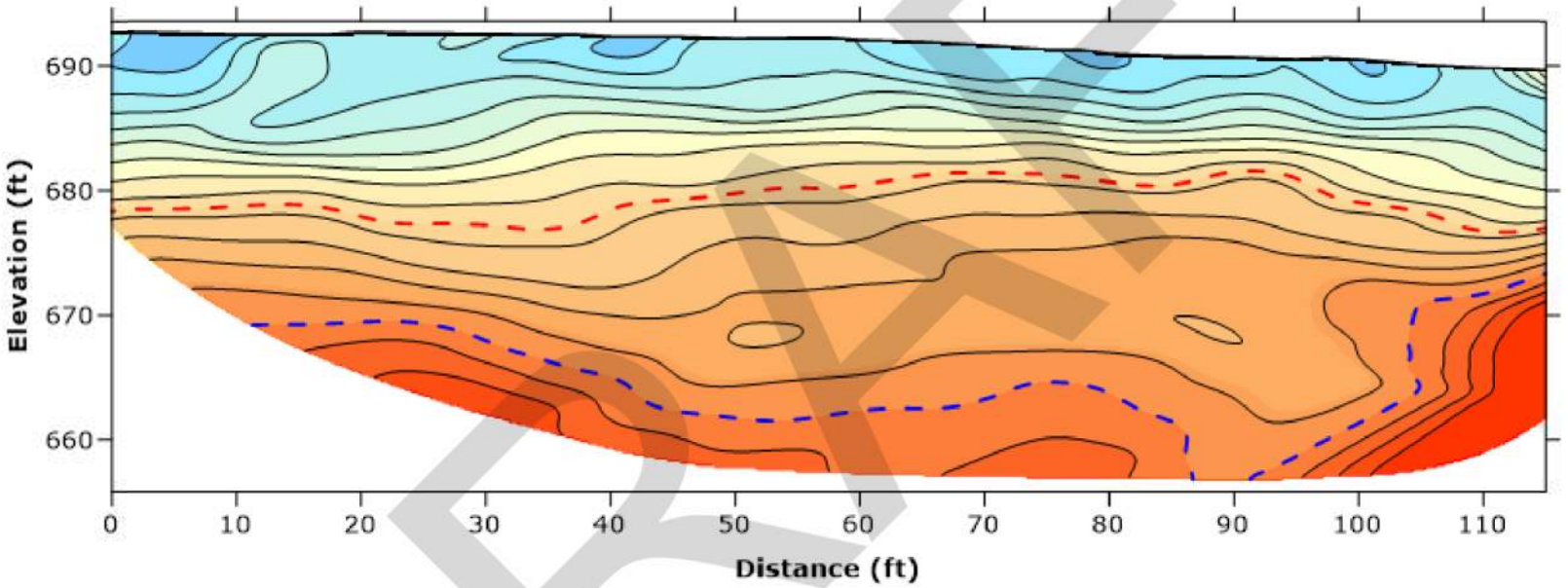
Terracon

Date: 06/2025 | Project Number: 04255087

Seismic Refraction Results - SR-2	Exhibit
Project Clydesdale Design Level Sperry, Oklahoma	4

DRAFT

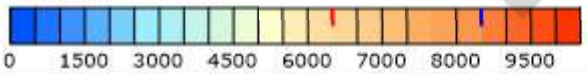
SR-3EW



Up to 6,300 ft/s rippable with D8R/D8T

Up to 8,500 ft/s marginally rippable with D8R/D8T
Velocities over this threshold may be unrippable

P-Wave Velocity (ft/s) - CI = 1000



Terracon

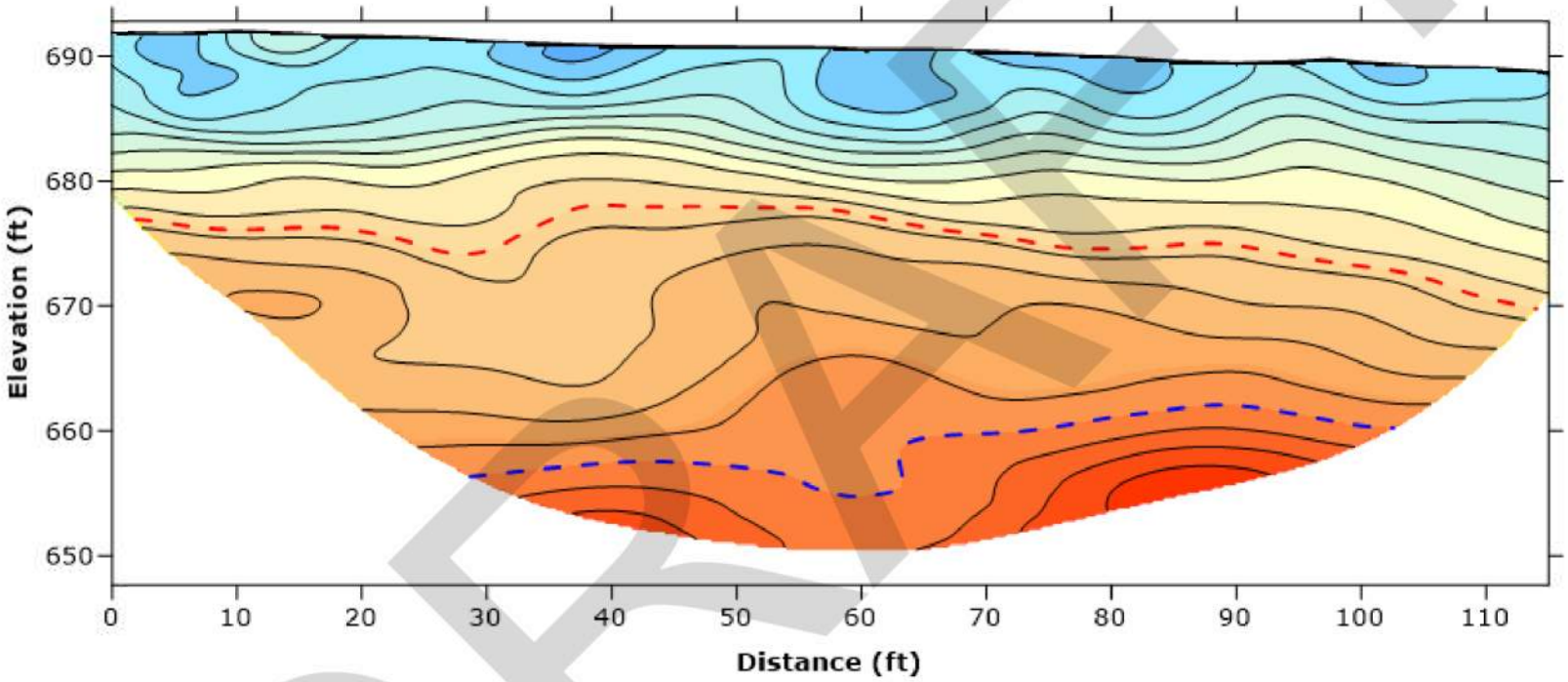
Date: 06/2025 | Project Number: 04255087

Seismic Refraction Results - SR-3EW	Exhibit
Project Clydesdale Design Level Sperry, Oklahoma	5

DRAFT

DRAFT

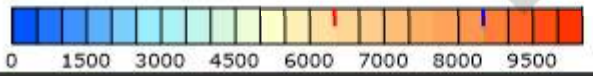
SR-3NS



- - - Up to 6,300 ft/s rippable with D8R/D8T

- - - Up to 8,500 ft/s marginally rippable with D8R/D8T
Velocities over this threshold may be unrippable

P-Wave Velocity (ft/s) - CI = 1000



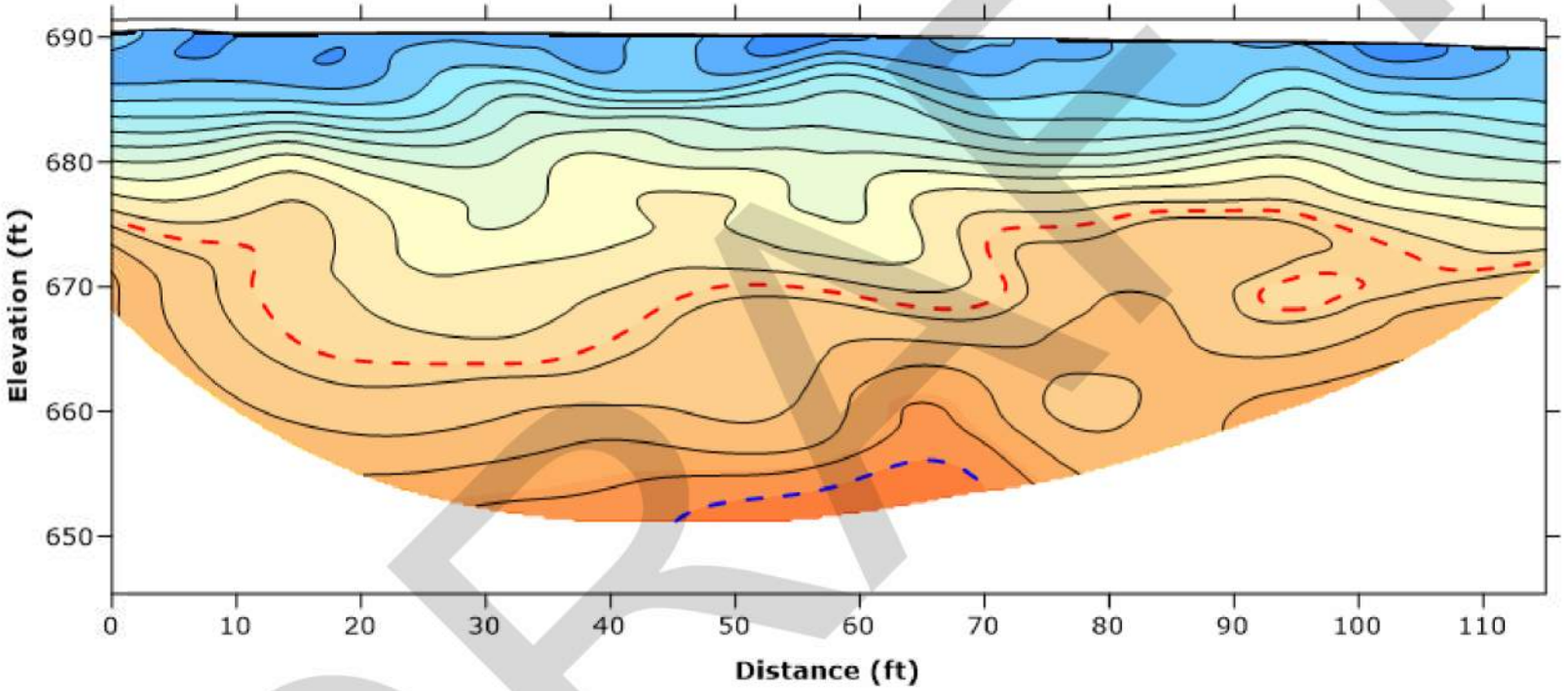
Terracon

Date: 06/2025 | Project Number: 04255087

Seismic Refraction Results - SR-3NS	Exhibit
Project Clydesdale Design Level Sperry, Oklahoma	6

DRAFT

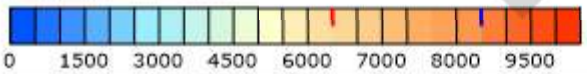
SR-4



Up to 6,300 ft/s rippable with D8R/D8T

Up to 8,500 ft/s marginally rippable with D8R/D8T
Velocities over this threshold may be unrippable

P-Wave Velocity (ft/s) - CI = 1000



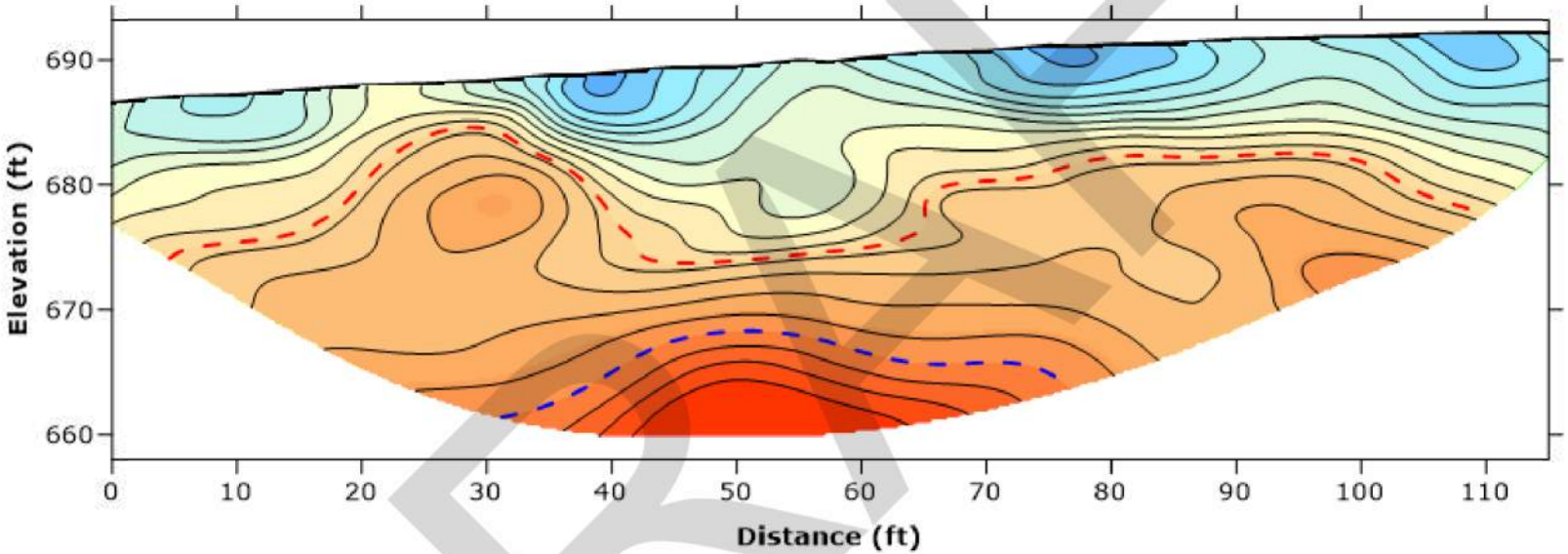
Terracon

Date: 06/2025 | Project Number: 04255087

Seismic Refraction Results - SR-4	Exhibit
Project Clydesdale Design Level Sperry, Oklahoma	7

DRAFT

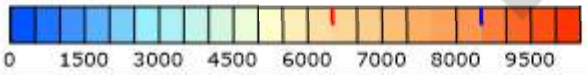
SR-5



Up to 6,300 ft/s rippable with D8R/D8T

Up to 8,500 ft/s marginally rippable with D8R/D8T
Velocities over this threshold may be unrippable

P-Wave Velocity (ft/s) - CI = 1000



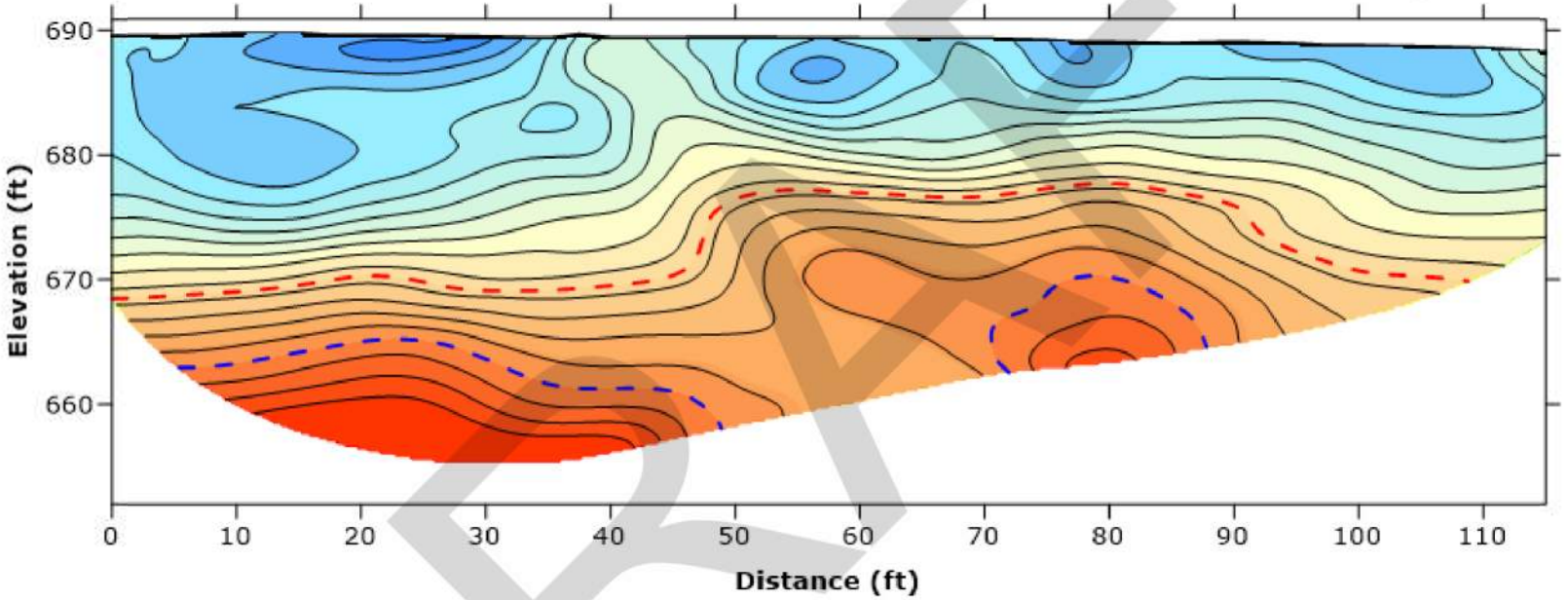
Terracon

Date: 06/2025 | Project Number: 04255087

Seismic Refraction Results - SR-5	Exhibit
Project Clydesdale Design Level Sperry, Oklahoma	8

DRAFT

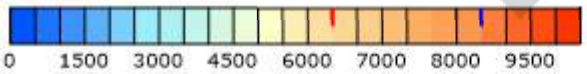
SR-6



Up to 6,300 ft/s rippable with D8R/D8T

Up to 8,500 ft/s marginally rippable with D8R/D8T
Velocities over this threshold may be unrippable

P-Wave Velocity (ft/s) - CI = 1000

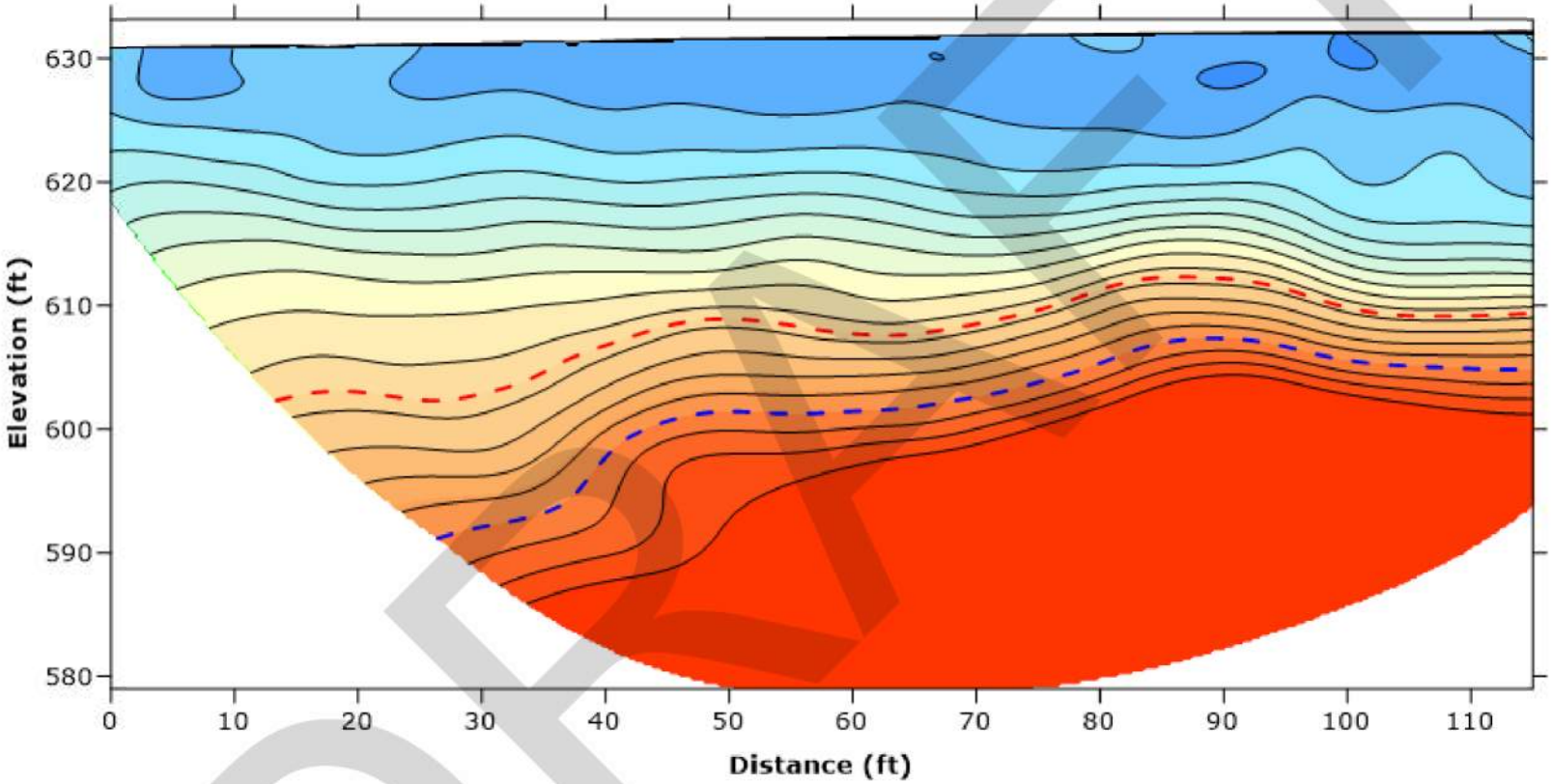


Terracon

Date: 06/2025 | Project Number: 04255087

Seismic Refraction Results - SR-6	Exhibit
Project Clydesdale Design Level Sperry, Oklahoma	9

SR-7



Up to 6,300 ft/s rippable with D8R/D8T

Up to 8,500 ft/s marginally rippable with D8R/D8T
Velocities over this threshold may be unrippable

P-Wave Velocity (ft/s) - CI = 1000

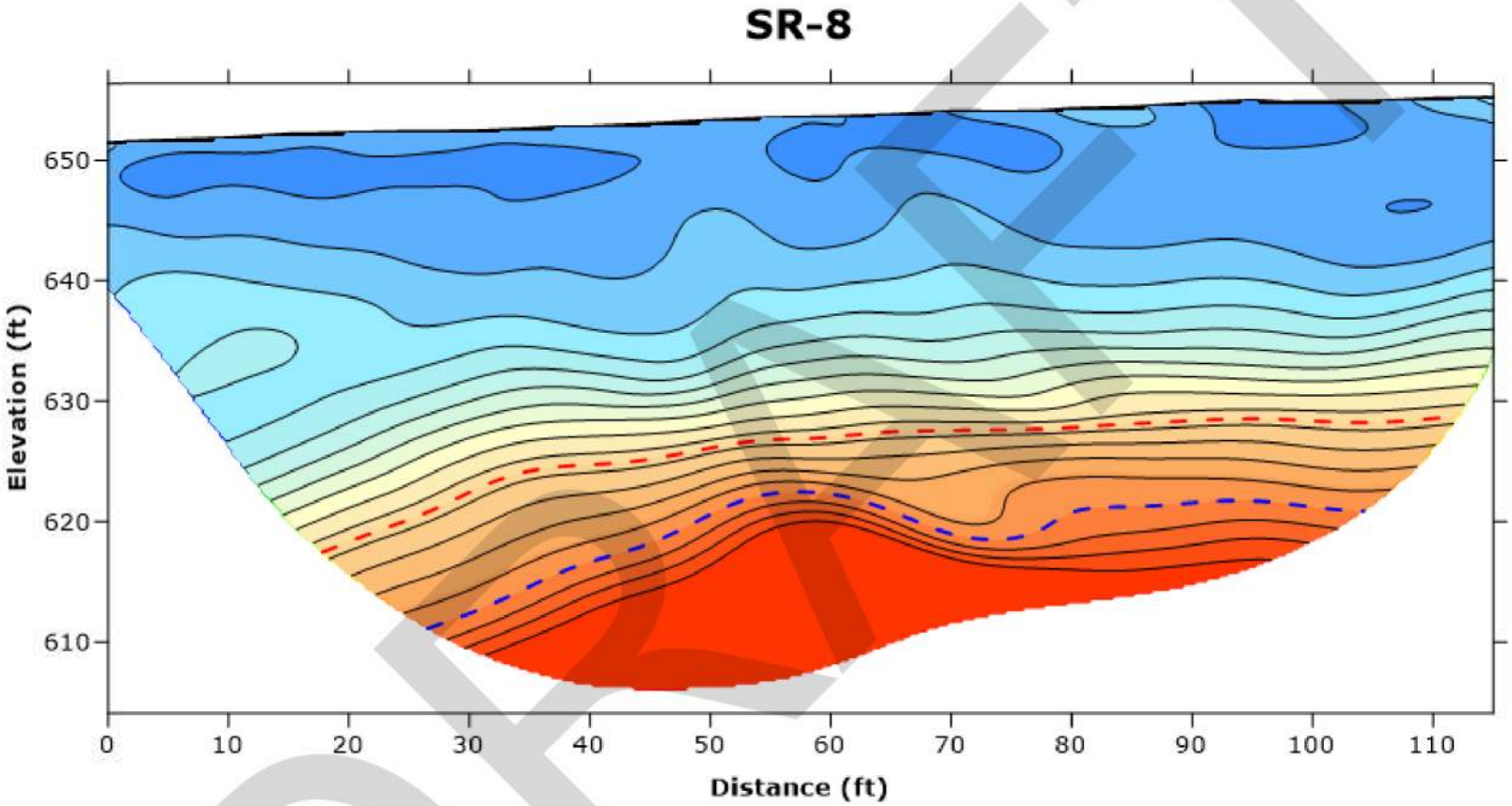
0 1500 3000 4500 6000 7000 8000 9500

Terracon

Date: 06/2025 | Project Number: 04255087

Seismic Refraction Results - SR-7	Exhibit
Project Clydesdale Design Level Sperry, Oklahoma	10

DRAFT



Up to 6,300 ft/s rippable with D8R/D8T

Up to 8,500 ft/s marginally rippable with D8R/D8T
Velocities over this threshold may be unrippable

P-Wave Velocity (ft/s) - CI = 1000

0 1500 3000 4500 6000 7000 8000 9500

Terracon

Date: 06/2025 | Project Number: 04255087

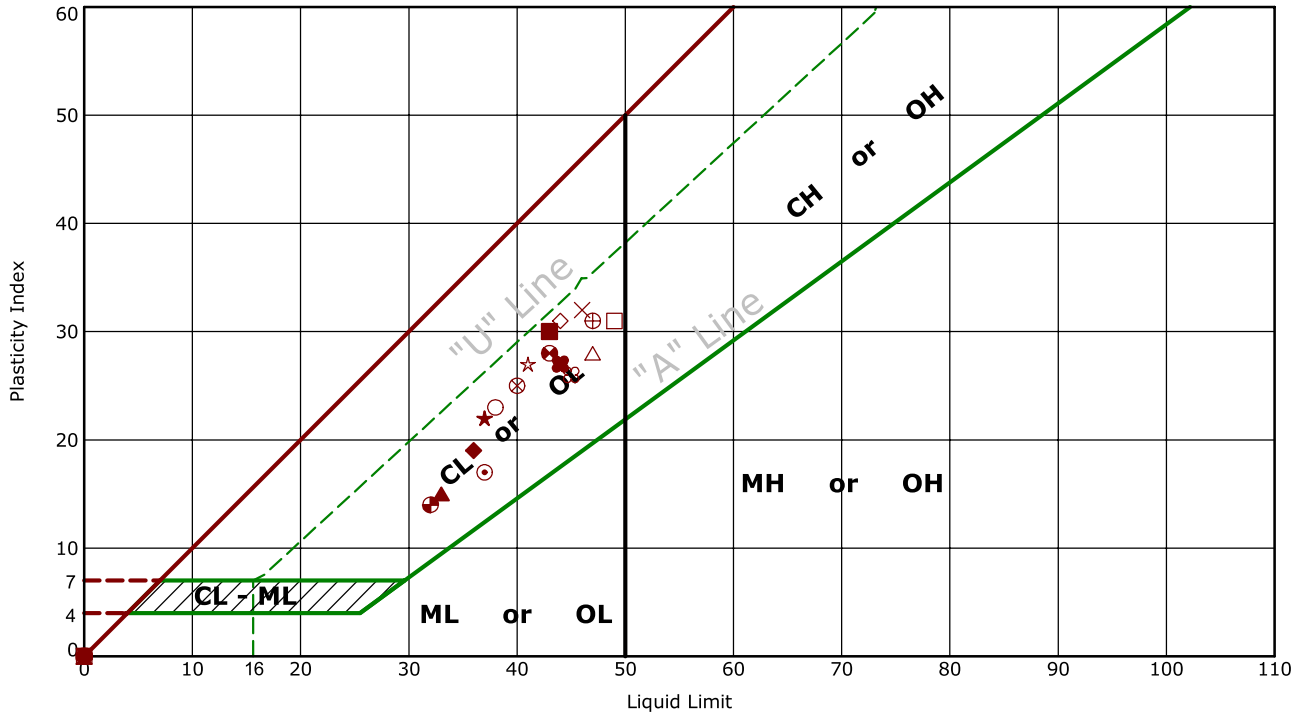
Seismic Refraction Results - SR-8	Exhibit
Project Clydesdale Design Level Sperry, Oklahoma	10

DRAFT

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Atterberg Limit Results

ASTM D4318



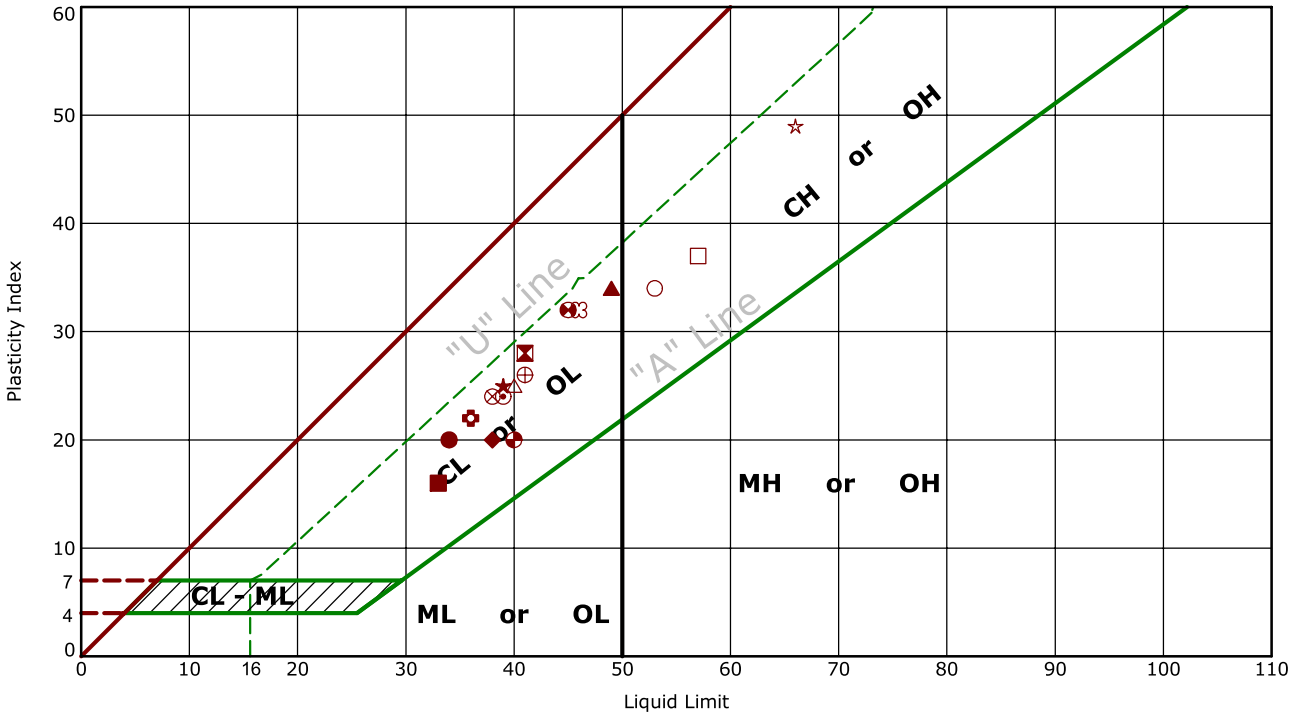
	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-192	0.5 - 1.6	NP	NP	NP	50.4	ML	SANDY SILT
⊠	B-193	3.5 - 5	NP	NP	NP	49.1	SM	SILTY SAND
▲	B-194	13.5 - 15	33	18	15	67.6	CL	SANDY LEAN CLAY
★	B-195	3.5 - 5	37	15	22	77.3	CL	LEAN CLAY with SAND
⊙	B-196	5 - 6.5	37	20	17	59.0	CL	SANDY LEAN CLAY
✿	B-197	2 - 3.5	NP	NP	NP	40.6	SM	SILTY SAND
○	B-199	8.5 - 10	38	15	23	86.3	CL	LEAN CLAY
△	B-200	0.5 - 2	47	19	28	90.4	CL	LEAN CLAY
⊗	B-200	8.5 - 10	40	15	25	89.8	CL	LEAN CLAY
⊕	B-201	5 - 6.5	47	16	31	90.1	CL	LEAN CLAY
□	B-202	2 - 3.5	49	18	31	87.5	CL	LEAN CLAY
⊗	B-203	0.5 - 2	43	15	28	86.7	CL	LEAN CLAY
◒	B-204	8.5 - 10	32	18	14	56.1	CL	SANDY LEAN CLAY
☆	B-205	5 - 6.5	41	14	27	84.7	CL	LEAN CLAY with SAND
⊠	B-206	13.5 - 15	45	19	26	94.3	CL	LEAN CLAY
■	B-207	5 - 6.5	43	13	30	75.4	CL	LEAN CLAY with SAND
◆	B-208	2 - 3.5	36	17	19	74.9	CL	LEAN CLAY with SAND
◇	B-209	5 - 6.5	44	13	31	85.9	CL	LEAN CLAY
⊠	B-210	2 - 3.5	46	14	32	85.2	CL	LEAN CLAY
⊠	B-211	2 - 3.5	44	17	27	88.5	CL	LEAN CLAY

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Atterberg Limit Results

ASTM D4318

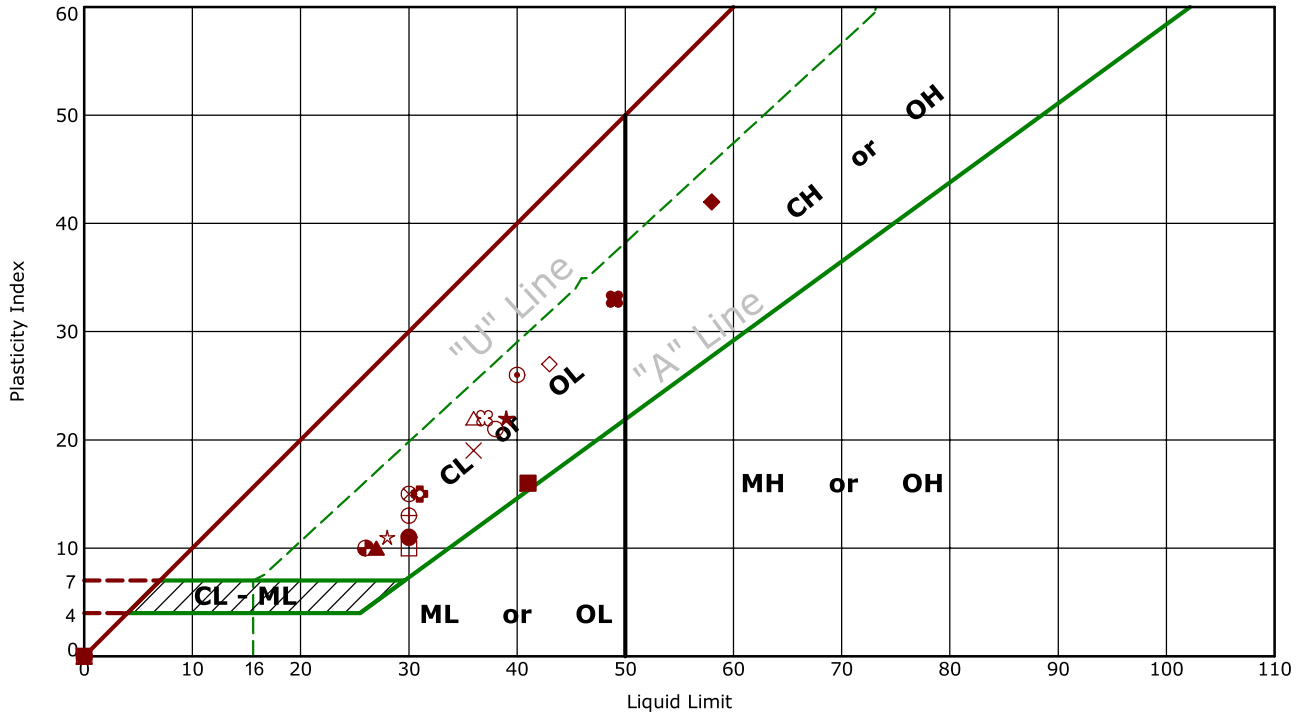


	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-211	8.5 - 10	34	14	20	52.2	CL	SANDY LEAN CLAY
⊠	B-212	3.5 - 5	41	13	28	91.0	CL	LEAN CLAY
▲	B-213	3.5 - 5	49	15	34	82.4	CL	LEAN CLAY with SAND
★	B-214	5 - 6.5	39	14	25	86.9	CL	LEAN CLAY
⊙	B-215	3.5 - 5	39	15	24	88.9	CL	LEAN CLAY
✿	B-216	13.5 - 15	36	14	22	88.8	CL	LEAN CLAY
○	B-217	3.5 - 5	53	19	34	88.3	CH	FAT CLAY
△	B-218	2 - 3.5	40	15	25	86.7	CL	LEAN CLAY
⊗	B-219	8.5 - 10	38	14	24	75.8	CL	LEAN CLAY with SAND
⊕	B-220	5 - 6.5	41	15	26	71.0	CL	LEAN CLAY with SAND
□	B-221	5 - 6.5	57	20	37	89.0	CH	FAT CLAY
⊠	B-222	3.5 - 5	45	13	32	85.0	CL	LEAN CLAY with SAND
◒	B-223	2 - 3.5	40	20	20	90.2	CL	LEAN CLAY
☆	B-224	0.5 - 2	66	17	49	90.2	CH	FAT CLAY
⊠	B-226	5 - 6.5	46	14	32	80.8	CL	LEAN CLAY with SAND
■	B-227	8.5 - 10	33	17	16	56.3	CL	SANDY LEAN CLAY
◆	B-228	2 - 3.5	38	18	20	77.1	CL	LEAN CLAY with SAND

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Atterberg Limit Results

ASTM D4318

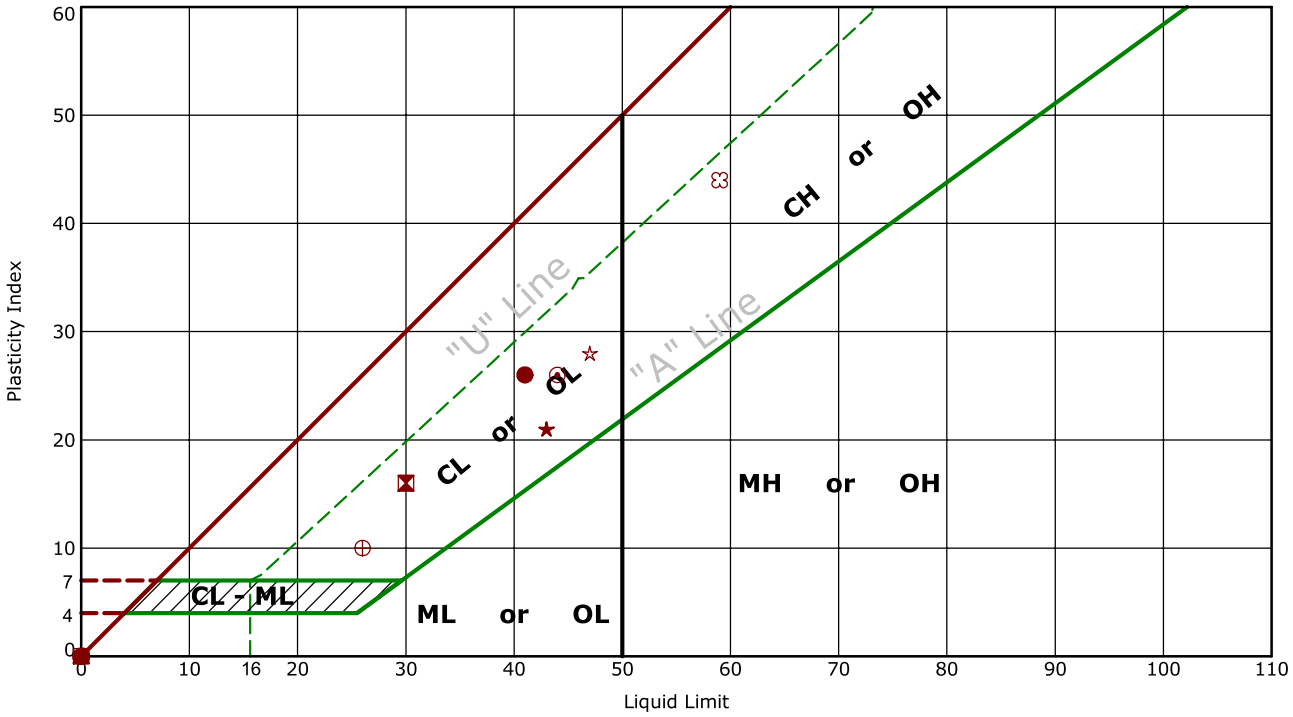


	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-156	2 - 3.5	30	19	11	83.2	CL	LEAN CLAY with SAND
⊠	B-157	0.5 - 2	NP	NP	NP	57.0	ML	SANDY SILT
▲	B-158	3.5 - 5	27	17	10	92.4	CL	LEAN CLAY
★	B-159	3.5 - 5	39	17	22	75.1	CL	LEAN CLAY with SAND
⊙	B-160	0.5 - 2	40	14	26	81.2	CL	LEAN CLAY with SAND
✿	B-161	8.5 - 10	31	16	15	76.3	CL	LEAN CLAY with SAND
○	B-162	5 - 6.5	38	17	21	82.8	CL	LEAN CLAY with SAND
△	B-163	0.5 - 2	36	14	22	81.2	CL	LEAN CLAY with SAND
⊗	B-164	2 - 3.5	30	15	15	76.0	CL	LEAN CLAY with SAND
⊕	B-164	6.5 - 8.5	30	17	13	88.3	CL	LEAN CLAY
□	B-165	2 - 3.5	30	20	10	85.3	CL	LEAN CLAY
⊛	B-166	0.5 - 2	NP	NP	NP	58.3	ML	SANDY SILT
◒	B-167	2 - 3.5	26	16	10	72.7	CL	LEAN CLAY with SAND
☆	B-168	5 - 6.5	28	17	11	64.2	CL	SANDY LEAN CLAY
⊠	B-169	5 - 6.5	37	15	22	81.2	CL	LEAN CLAY with SAND
■	B-170	3.5 - 5	41	25	16	99.6	CL	LEAN CLAY
◆	B-171	1 - 1	58	16	42			
◇	B-171	2 - 3.5	43	16	27	86.3	CL	LEAN CLAY
✕	B-171	5 - 6.5	36	17	19	94.6	CL	LEAN CLAY
✱	B-171	6.5 - 8.5	49	16	33			

9522 E 47th Pl, Ste D
Tulsa, OK

Atterberg Limit Results

ASTM D4318

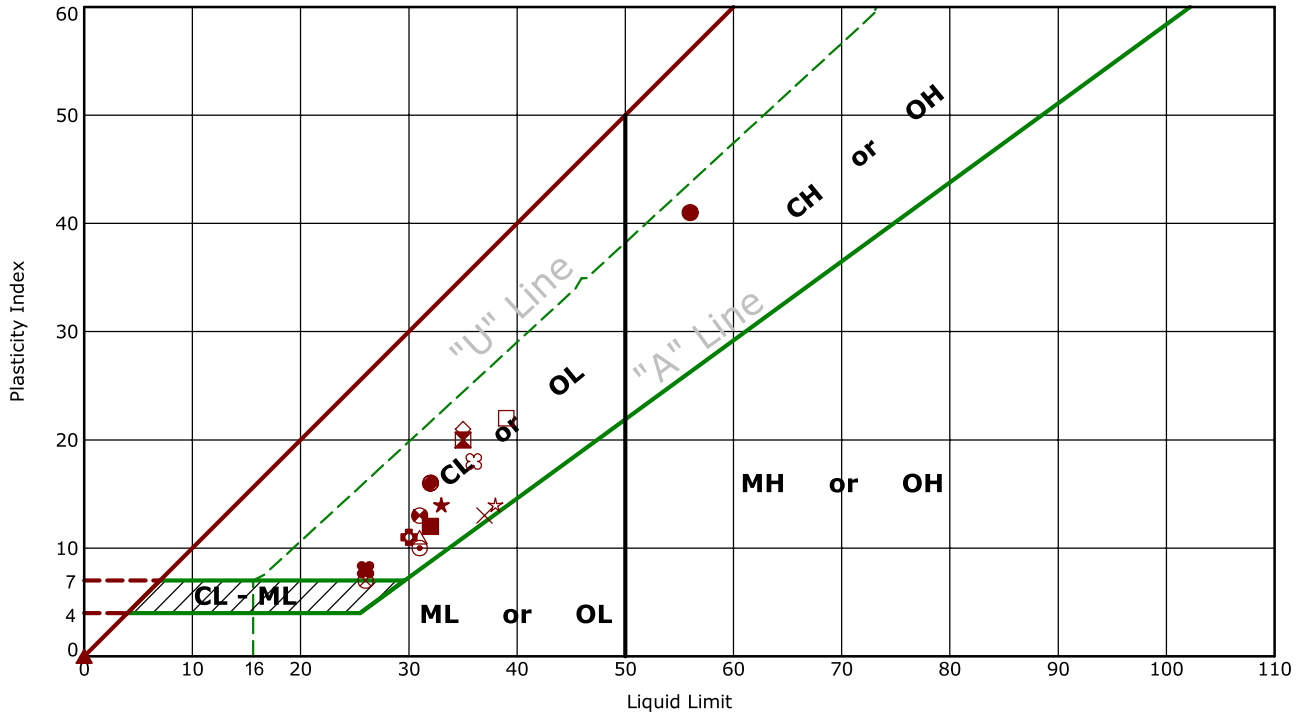


	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-172	2 - 3.5	41	15	26	59.4	CL	SANDY LEAN CLAY
⊠	B-173	3.5 - 5	30	14	16	63.9	CL	SANDY LEAN CLAY
▲	B-176	0.5 - 2	NP	NP	NP	37.8	SM	SILTY SAND
★	B-178	8.5 - 10	43	22	21	99.0	CL	LEAN CLAY
⊙	B-180	2 - 3.5	44	18	26	83.3	CL	LEAN CLAY with SAND
✿	B-181	0.5 - 2	NP	NP	NP	33.4	SM	SILTY SAND
○	B-183	0.5 - 2	NP	NP	NP	37.4	SM	SILTY SAND
△	B-185	2 - 3.5	NP	NP	NP	38.5	SM	SILTY SAND
⊗	B-187	0.5 - 1.3	NP	NP	NP			
⊕	B-188	0.5 - 1.3	26	16	10	49.9	SC	CLAYEY SAND
□	B-189	2 - 3.5	NP	NP	NP	57.6	ML	SANDY SILT
⊛	B-190	0.5 - 2	NP	NP	NP	39.5	SM	SILTY SAND
◒	B-191	3.5 - 5	NP	NP	NP	72.4	ML	SILT with SAND
☆	B-225	2 - 3.5	47	19	28	87.8	CL	LEAN CLAY
⊠	B-225	6.5	59	15	44	89.9	CH	FAT CLAY

9522 E 47th Pl, Ste D
Tulsa, OK

Atterberg Limit Results

ASTM D4318

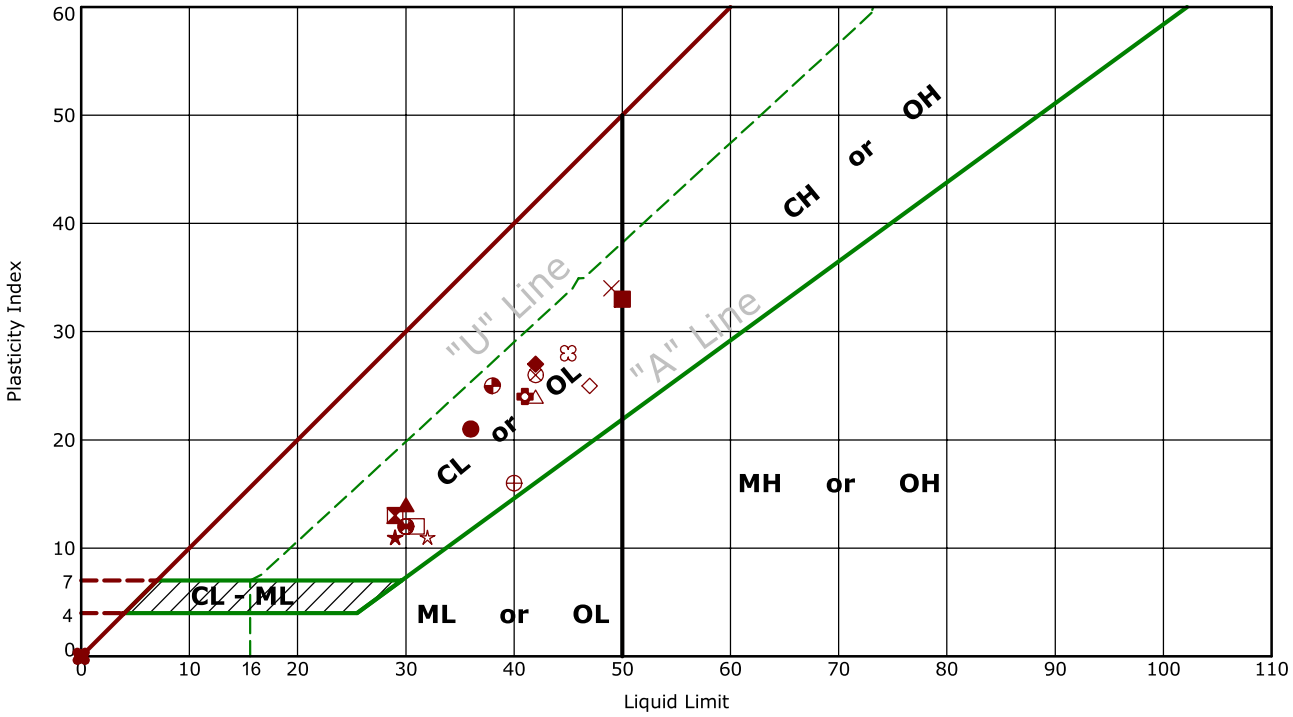


	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-101	2 - 3.5	56	15	41	83.4	CH	FAT CLAY with SAND
⊠	B-101	5 - 5.6	35	15	20	80.9	CL	LEAN CLAY with SAND
▲	B-102	0.5 - 2	NP	NP	NP		CL	LEAN CLAY
★	B-103	0.5 - 2	33	19	14	77.2	CL	LEAN CLAY with SAND
⊙	B-105	0.5 - 2	31	21	10	84.5	CL	LEAN CLAY with SAND
✿	B-106	5 - 6.5	30	19	11	84.3	CL	LEAN CLAY with SAND
○	B-107	2 - 3.5	32	16	16	97.7	CL	LEAN CLAY
△	B-108A	3.5 - 5	31	20	11	75.0	CL	LEAN CLAY with SAND
⊗	B-109	2 - 3.5	26	19	7	58.5	CL-ML	SANDY SILTY CLAY
⊕	B-111A	3.5 - 5	32	16	16	86.9	CL	LEAN CLAY
□	B-112	0.5 - 2	39	17	22	66.4	CL	SANDY LEAN CLAY
⊛	B-113A	3.5 - 5	31	18	13	89.8	CL	LEAN CLAY
◒	B-115A	5 - 6.5	32	16	16	90.1	CL	LEAN CLAY
☆	B-116A	5 - 6.5	38	24	14			
⊠	B-117	5 - 6.5	36	18	18	98.9	CL	LEAN CLAY
■	B-118	0.5 - 2	32	20	12	97.1	CL	LEAN CLAY
◆	B-119	2 - 3.5	32	16	16	87.3	CL	LEAN CLAY
◇	B-121A	5 - 6.5	35	14	21	74.3	CL	LEAN CLAY with SAND
×	B-123	2 - 3.5	37	24	13	96.9	CL	LEAN CLAY
✿	B-124A	0.5 - 2	26	18	8	98.3	CL	LEAN CLAY

9522 E 47th Pl, Ste D
Tulsa, OK

Atterberg Limit Results

ASTM D4318

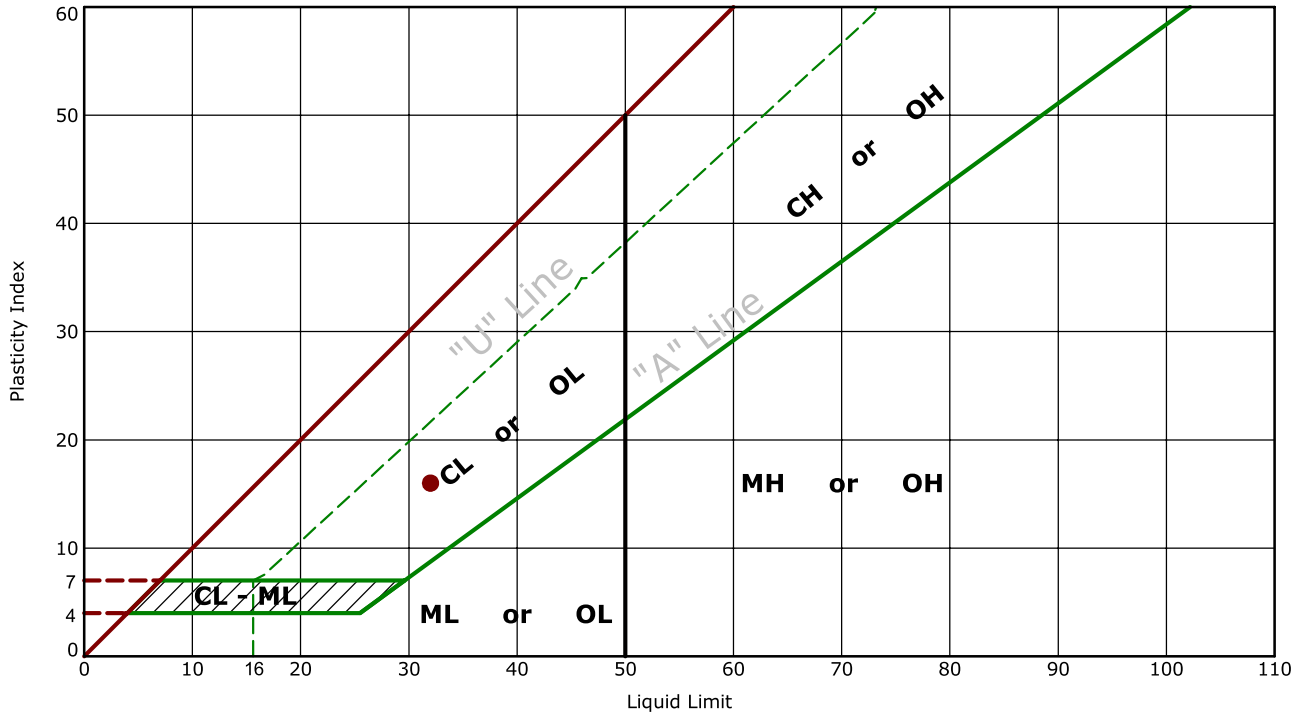


	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-125A	3.5 - 5	36	15	21	76.0	CL	LEAN CLAY with SAND
⊠	B-126	2 - 3.5	29	16	13	71.4	CL	LEAN CLAY with SAND
▲	B-127	2 - 3.5	30	16	14	81.6	CL	LEAN CLAY with SAND
★	B-129	0.5 - 2	29	18	11	72.1	CL	LEAN CLAY with SAND
⊙	B-130	2 - 3.5	30	18	12	88.8	CL	LEAN CLAY
✿	B-131	0.5 - 2	41	17	24	77.0	CL	LEAN CLAY with SAND
○	B-132	0.5 - 2	30	18	12	60.0	CL	SANDY LEAN CLAY
△	B-133	2 - 3.5	42	18	24	90.0	CL	LEAN CLAY
⊗	B-134	3.5 - 5	42	16	26	82.6	CL	LEAN CLAY with SAND
⊕	B-135	8.5 - 10	40	24	16	98.1	CL	LEAN CLAY
□	B-136	0.5 - 2	31	19	12	91.9	CL	LEAN CLAY
⊠	B-137	0.5 - 2	30	18	12	92.2	CL	LEAN CLAY
◒	B-140	5 - 6.5	38	13	25	94.0	CL	LEAN CLAY
☆	B-142	2 - 3	32	21	11	90.3	CL	LEAN CLAY
⊠	B-145	5 - 6.5	45	17	28	92.6	CL	LEAN CLAY
■	B-146	3.5 - 5	50	17	33	86.8	CH	FAT CLAY
◆	B-148	3.5 - 5	42	15	27	89.6	CL	LEAN CLAY
◇	B-149	2 - 3.5	47	22	25	95.2	CL	LEAN CLAY
×	B-150	0.5 - 2	49	15	34	88.5	CL	LEAN CLAY
✿	B-151	0.5 - 2	NP	NP	NP	49.2	CL	LEAN CLAY with SAND

9522 E 47th Pl, Ste D
Tulsa, OK

Atterberg Limit Results

ASTM D4318



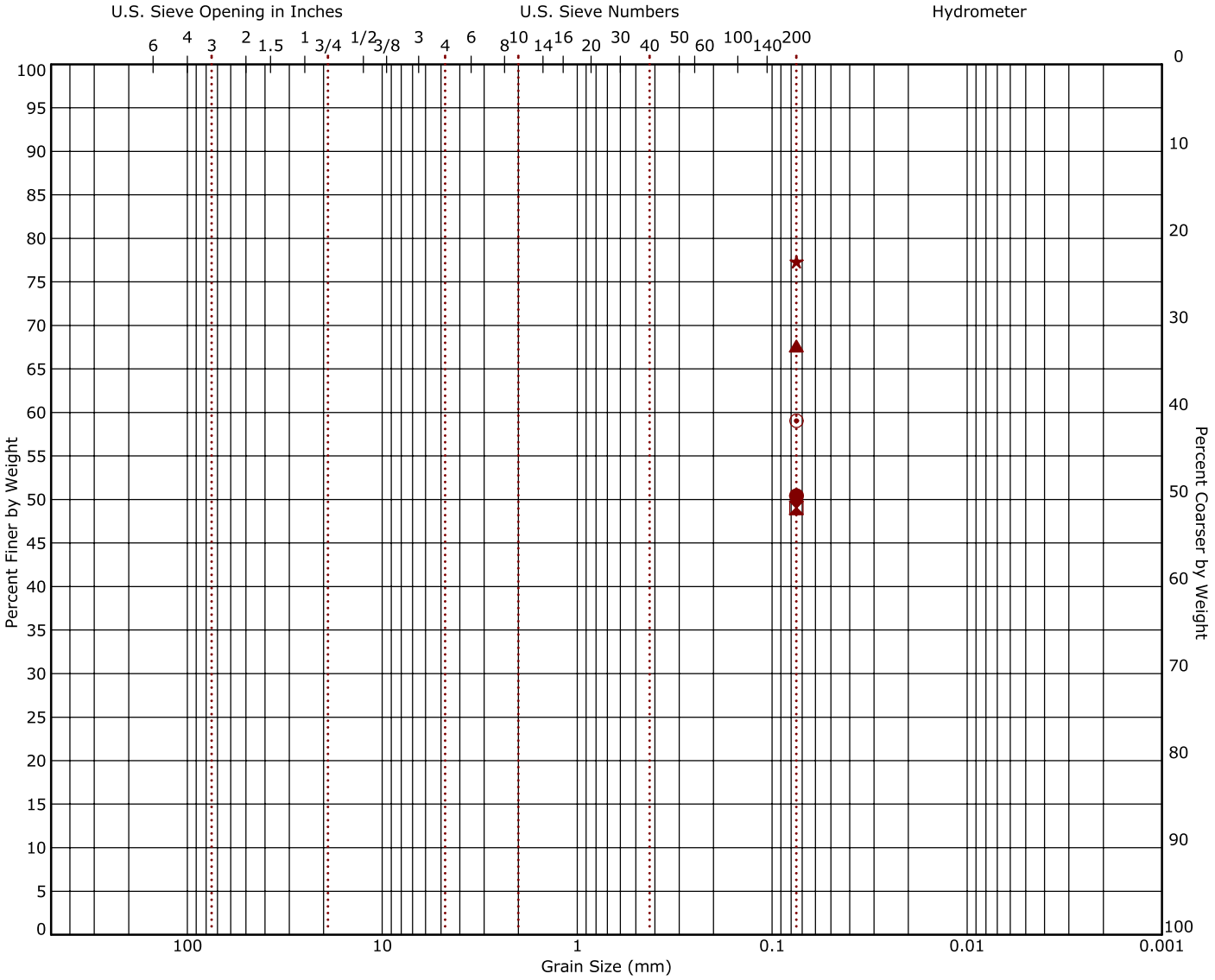
	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-152	3.5 - 5	32	16	16	90.7	CL	LEAN CLAY

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-192	0.5 - 1.6	SANDY SILT		NP	NP	NP		
⊠	B-193	3.5 - 5	SILTY SAND		NP	NP	NP		
▲	B-194	13.5 - 15	SANDY LEAN CLAY		33	18	15		
★	B-195	3.5 - 5	LEAN CLAY with SAND		37	15	22		
⊙	B-196	5 - 6.5	SANDY LEAN CLAY		37	20	17		

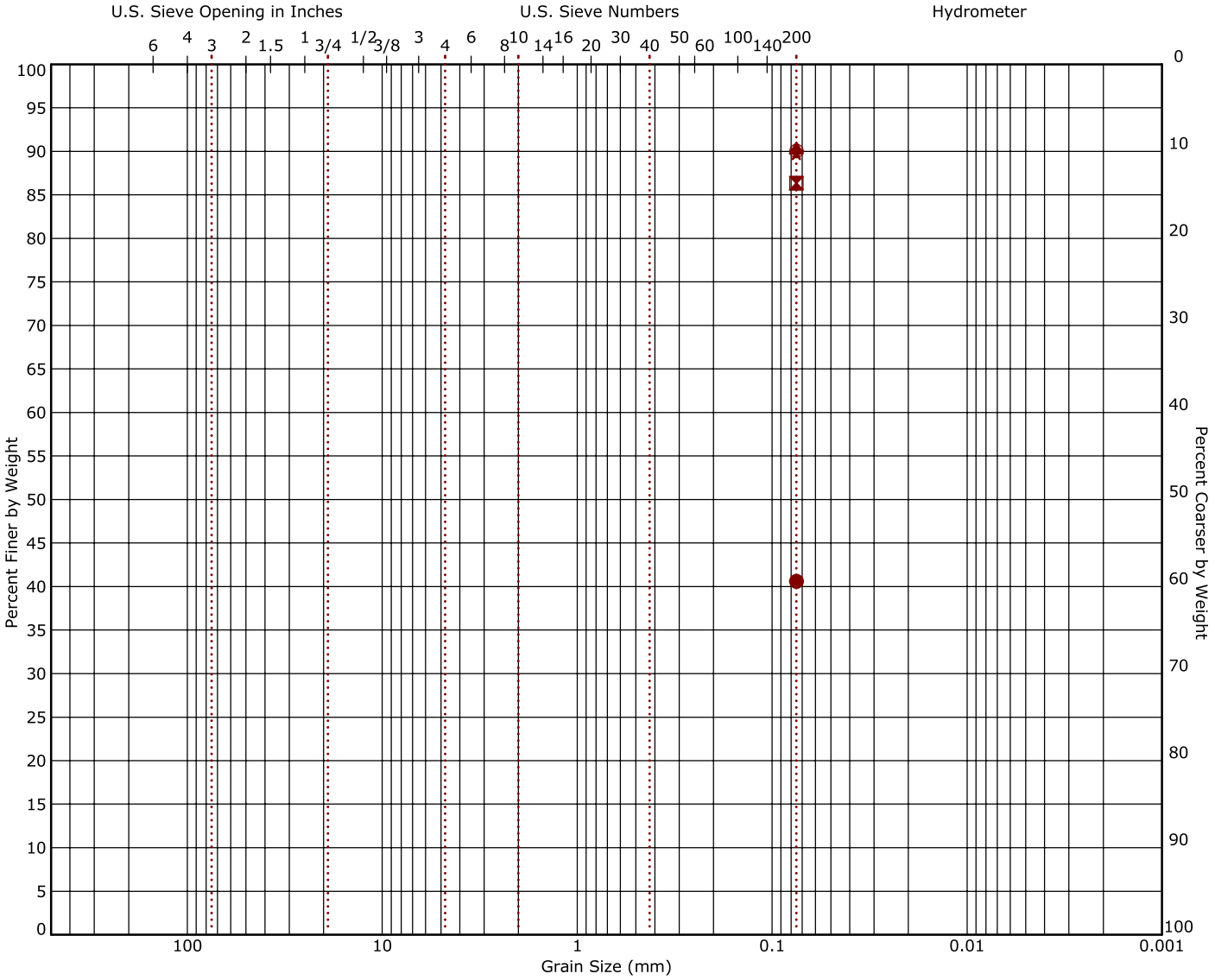
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-192	0.5 - 1.6	0.075							50.4		
⊠	B-193	3.5 - 5	0.075							49.1		
▲	B-194	13.5 - 15	0.075							67.6		
★	B-195	3.5 - 5	0.075							77.3		
⊙	B-196	5 - 6.5	0.075							59.0		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-197	2 - 3.5	SILTY SAND		NP	NP	NP		
⊠	B-199	8.5 - 10	LEAN CLAY		38	15	23		
▲	B-200	0.5 - 2	LEAN CLAY		47	19	28		
★	B-200	8.5 - 10	LEAN CLAY		40	15	25		
⊙	B-201	5 - 6.5	LEAN CLAY		47	16	31		

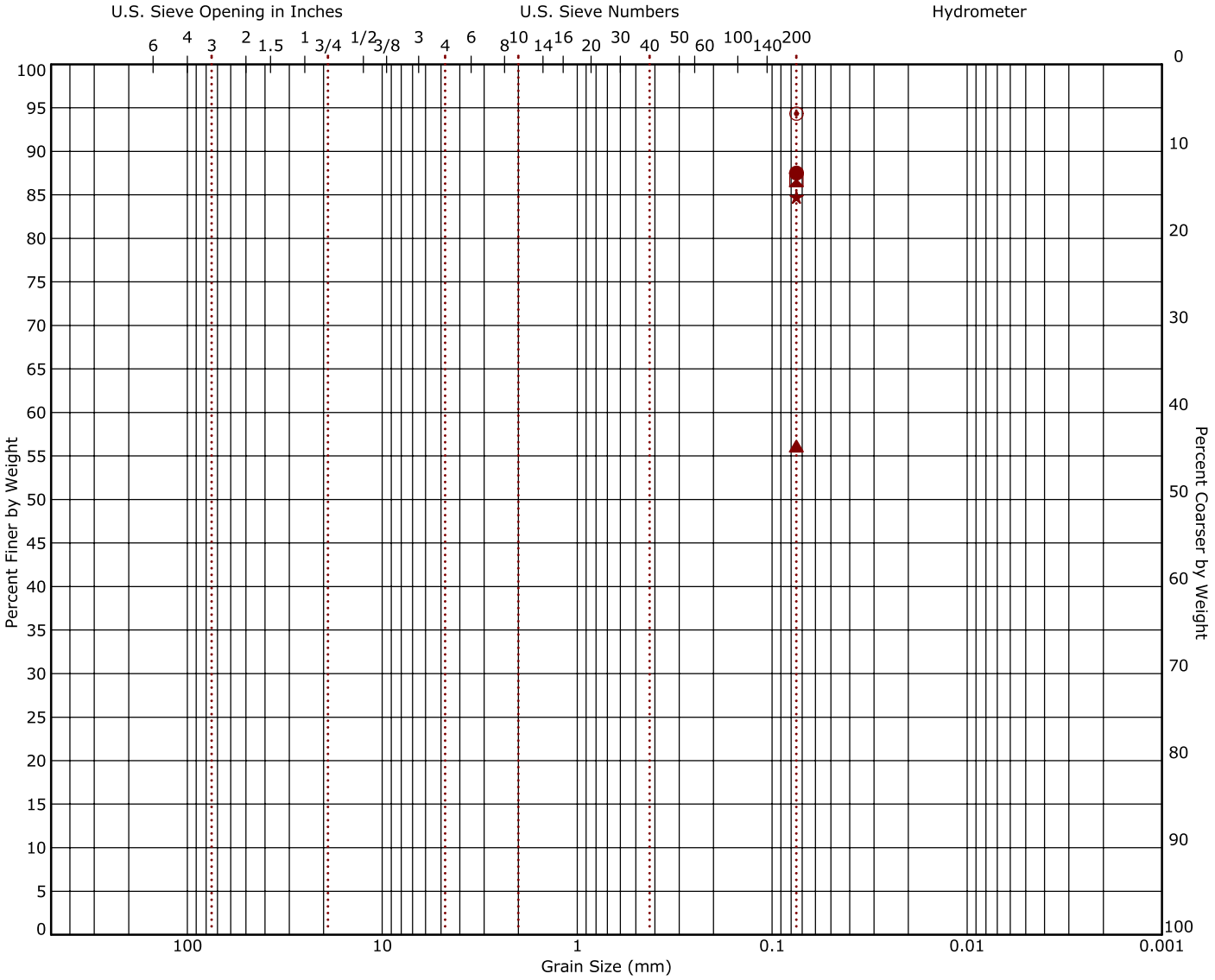
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-197	2 - 3.5	0.075							40.6		
⊠	B-199	8.5 - 10	0.075							86.3		
▲	B-200	0.5 - 2	0.075							90.4		
★	B-200	8.5 - 10	0.075							89.8		
⊙	B-201	5 - 6.5	0.075							90.1		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-202	2 - 3.5	LEAN CLAY		49	18	31		
⊠	B-203	0.5 - 2	LEAN CLAY		43	15	28		
▲	B-204	8.5 - 10	SANDY LEAN CLAY		32	18	14		
★	B-205	5 - 6.5	LEAN CLAY with SAND		41	14	27		
⊙	B-206	13.5 - 15	LEAN CLAY		45	19	26		

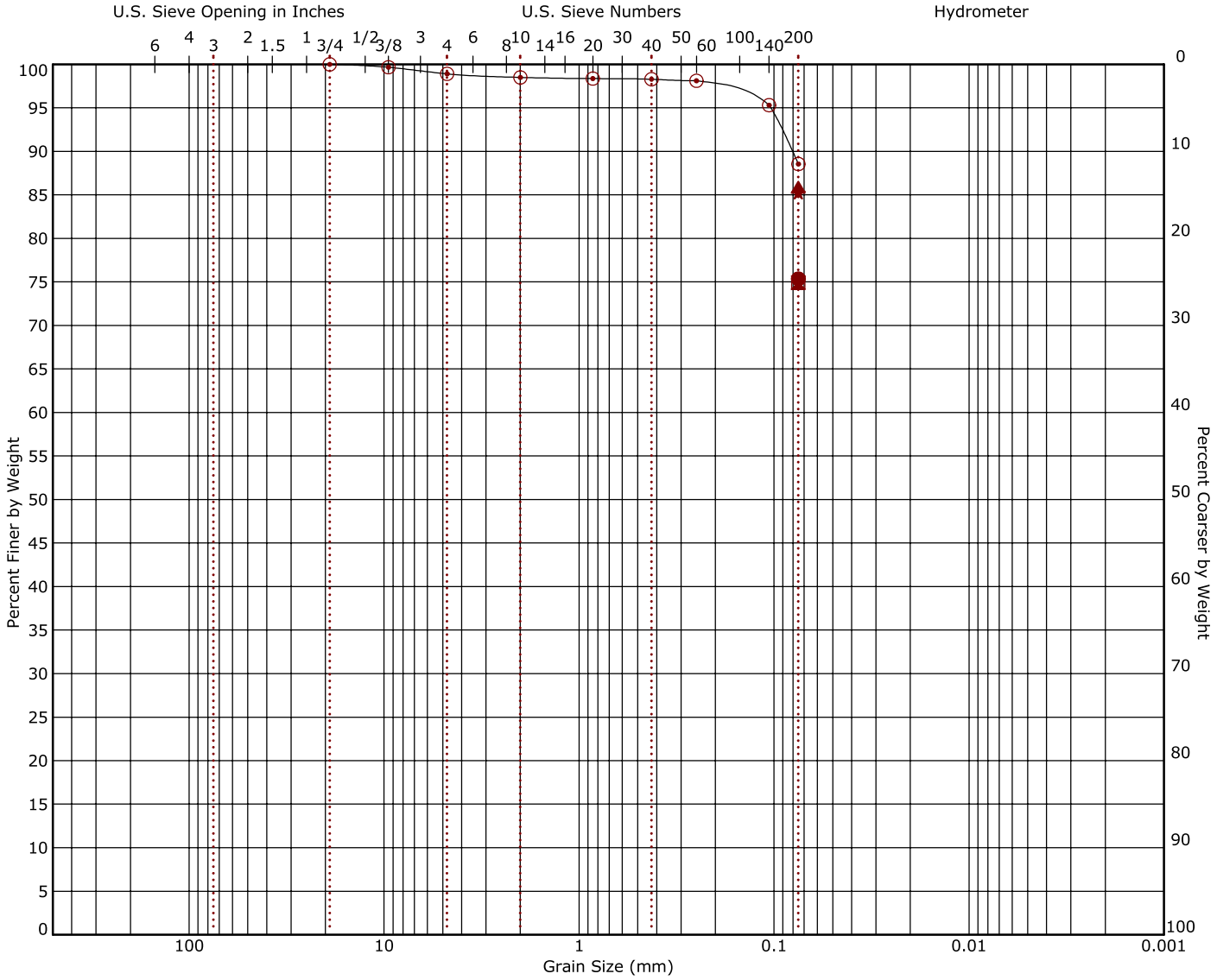
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-202	2 - 3.5	0.075							87.5		
⊠	B-203	0.5 - 2	0.075							86.7		
▲	B-204	8.5 - 10	0.075							56.1		
★	B-205	5 - 6.5	0.075							84.7		
⊙	B-206	13.5 - 15	0.075							94.3		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-207	5 - 6.5	LEAN CLAY with SAND		43	13	30		
⊠	B-208	2 - 3.5	LEAN CLAY with SAND		36	17	19		
▲	B-209	5 - 6.5	LEAN CLAY		44	13	31		
★	B-210	2 - 3.5	LEAN CLAY		46	14	32		
⊙	B-211	2 - 3.5	LEAN CLAY		44	17	27		

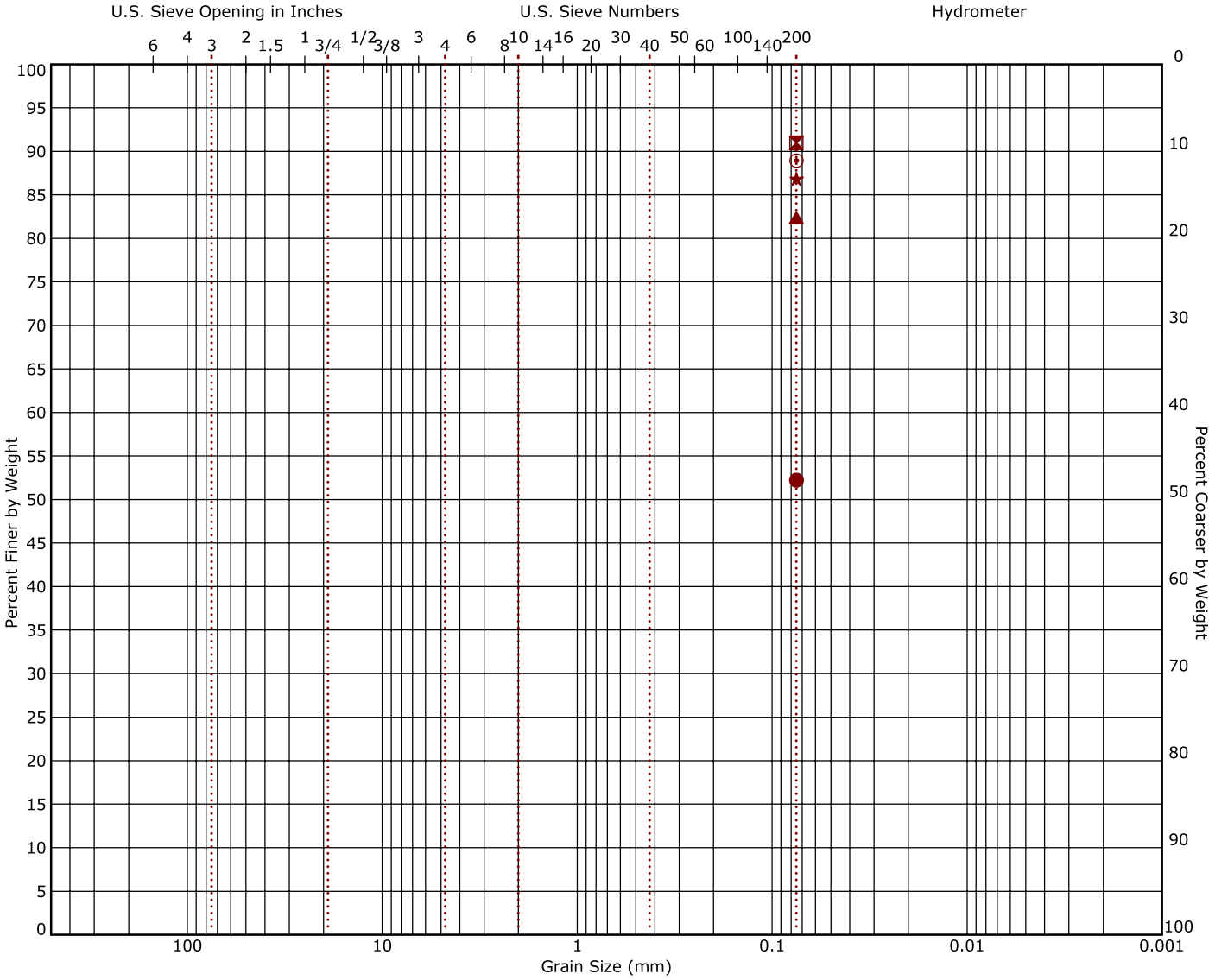
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-207	5 - 6.5	0.075							75.4		
⊠	B-208	2 - 3.5	0.075							74.9		
▲	B-209	5 - 6.5	0.075							85.9		
★	B-210	2 - 3.5	0.075							85.2		
⊙	B-211	2 - 3.5	19				0.0	1.1	10.4	88.5		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-211	8.5 - 10	SANDY LEAN CLAY		34	14	20		
⊠	B-212	3.5 - 5	LEAN CLAY		41	13	28		
▲	B-213	3.5 - 5	LEAN CLAY with SAND		49	15	34		
★	B-214	5 - 6.5	LEAN CLAY		39	14	25		
⊙	B-215	3.5 - 5	LEAN CLAY		39	15	24		

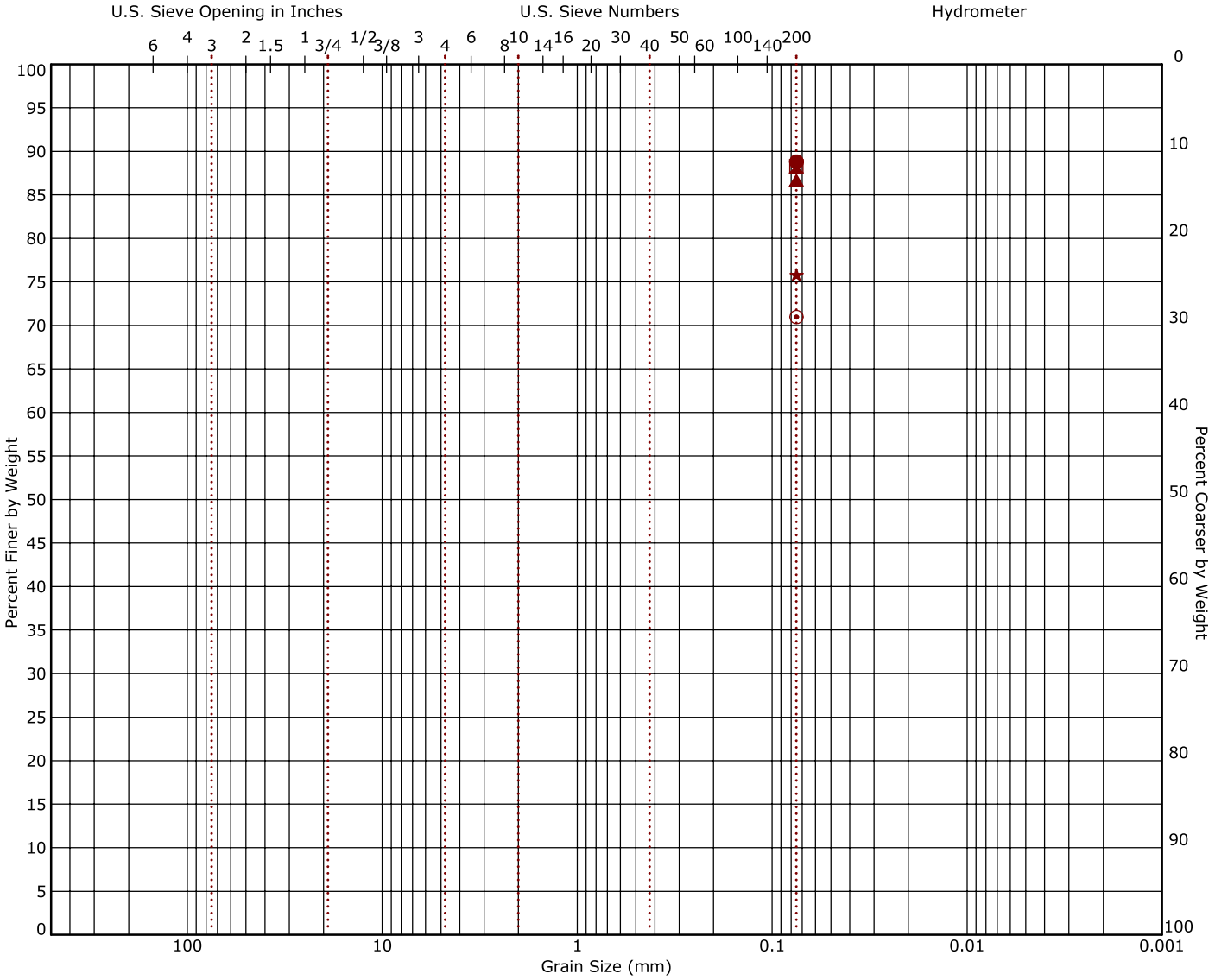
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-211	8.5 - 10	0.075							52.2		
⊠	B-212	3.5 - 5	0.075							91.0		
▲	B-213	3.5 - 5	0.075							82.4		
★	B-214	5 - 6.5	0.075							86.9		
⊙	B-215	3.5 - 5	0.075							88.9		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-216	13.5 - 15	LEAN CLAY		36	14	22		
⊠	B-217	3.5 - 5	FAT CLAY		53	19	34		
▲	B-218	2 - 3.5	LEAN CLAY		40	15	25		
★	B-219	8.5 - 10	LEAN CLAY with SAND		38	14	24		
⊙	B-220	5 - 6.5	LEAN CLAY with SAND		41	15	26		

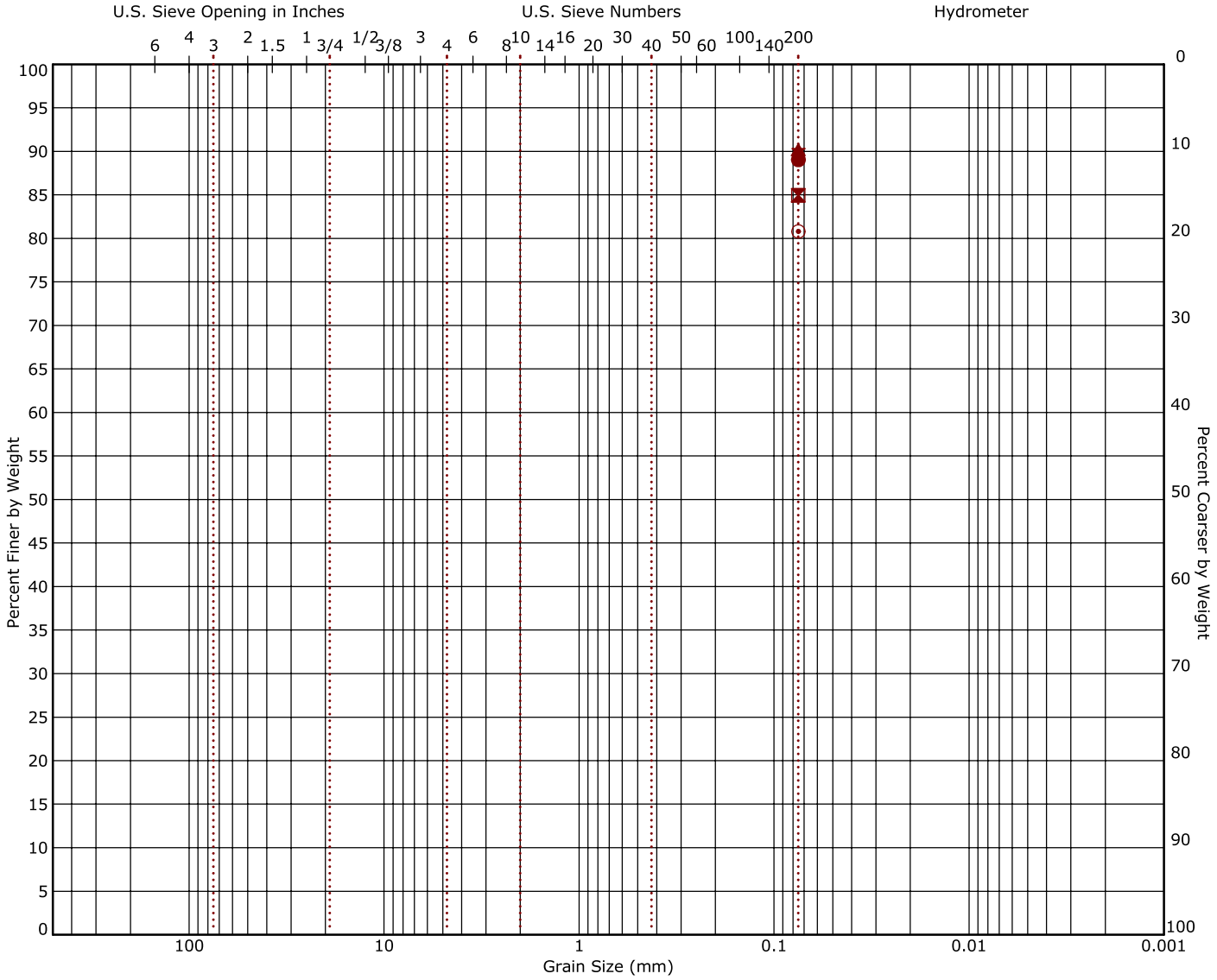
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-216	13.5 - 15	0.075							88.8		
⊠	B-217	3.5 - 5	0.075							88.3		
▲	B-218	2 - 3.5	0.075							86.7		
★	B-219	8.5 - 10	0.075							75.8		
⊙	B-220	5 - 6.5	0.075							71.0		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-221	5 - 6.5	FAT CLAY		57	20	37		
⊠	B-222	3.5 - 5	LEAN CLAY with SAND		45	13	32		
▲	B-223	2 - 3.5	LEAN CLAY		40	20	20		
★	B-224	0.5 - 2	FAT CLAY		66	17	49		
⊙	B-226	5 - 6.5	LEAN CLAY with SAND		46	14	32		

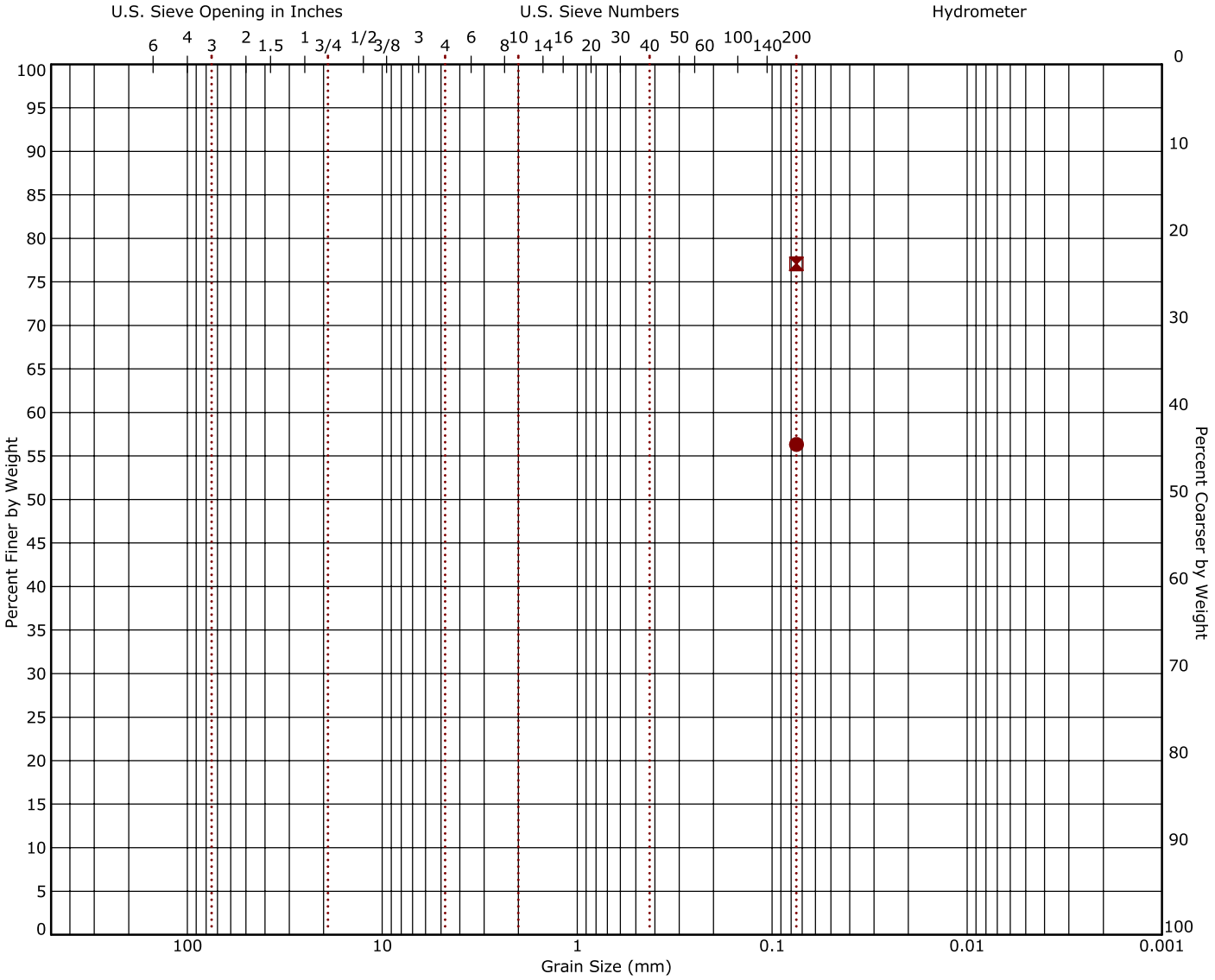
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-221	5 - 6.5	0.075							89.0		
⊠	B-222	3.5 - 5	0.075							85.0		
▲	B-223	2 - 3.5	0.075							90.2		
★	B-224	0.5 - 2	0.075							90.2		
⊙	B-226	5 - 6.5	0.075							80.8		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-227	8.5 - 10	SANDY LEAN CLAY		33	17	16		
⊠	B-228	2 - 3.5	LEAN CLAY with SAND		38	18	20		

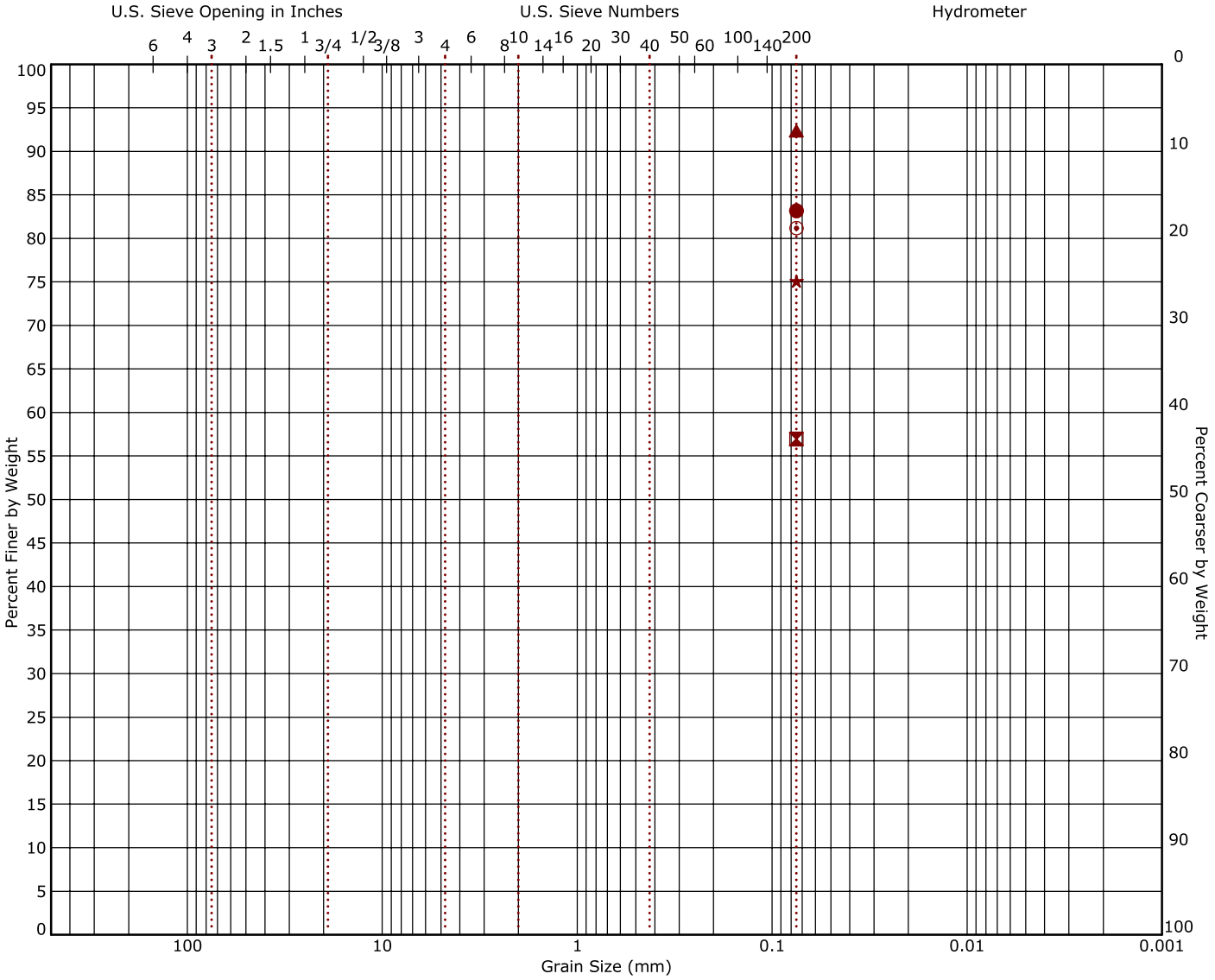
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-227	8.5 - 10	0.075							56.3		
⊠	B-228	2 - 3.5	0.075							77.1		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-156	2 - 3.5	LEAN CLAY with SAND		30	19	11		
⊠	B-157	0.5 - 2	SANDY SILT		NP	NP	NP		
▲	B-158	3.5 - 5	LEAN CLAY		27	17	10		
★	B-159	3.5 - 5	LEAN CLAY with SAND		39	17	22		
⊙	B-160	0.5 - 2	LEAN CLAY with SAND		40	14	26		

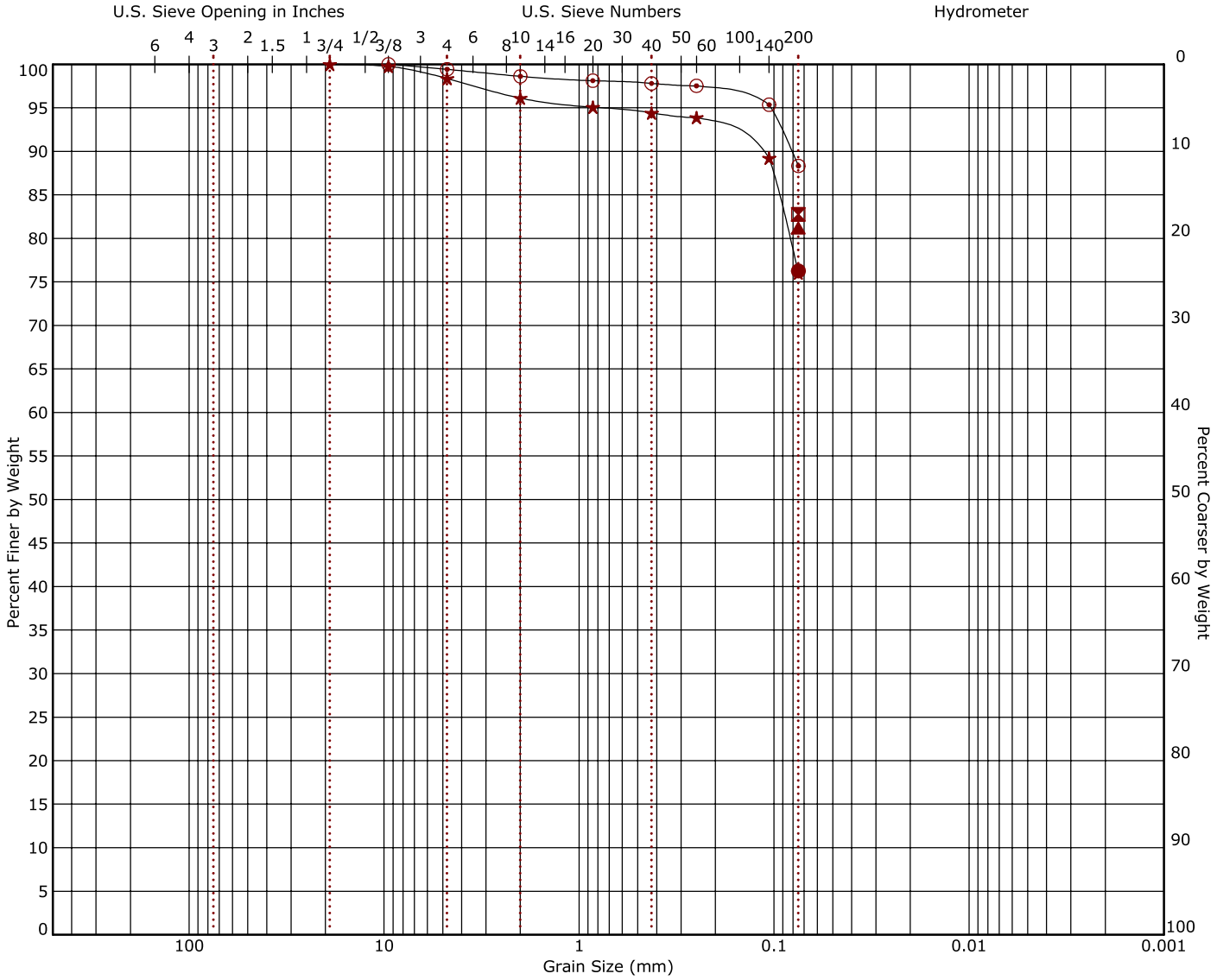
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-156	2 - 3.5	0.075							83.2		
⊠	B-157	0.5 - 2	0.075							57.0		
▲	B-158	3.5 - 5	0.075							92.4		
★	B-159	3.5 - 5	0.075							75.1		
⊙	B-160	0.5 - 2	0.075							81.2		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-161	8.5 - 10	LEAN CLAY with SAND		31	16	15		
⊠	B-162	5 - 6.5	LEAN CLAY with SAND		38	17	21		
▲	B-163	0.5 - 2	LEAN CLAY with SAND		36	14	22		
★	B-164	2 - 3.5	LEAN CLAY with SAND		30	15	15		
⊙	B-164	6.5 - 8.5	LEAN CLAY		30	17	13		

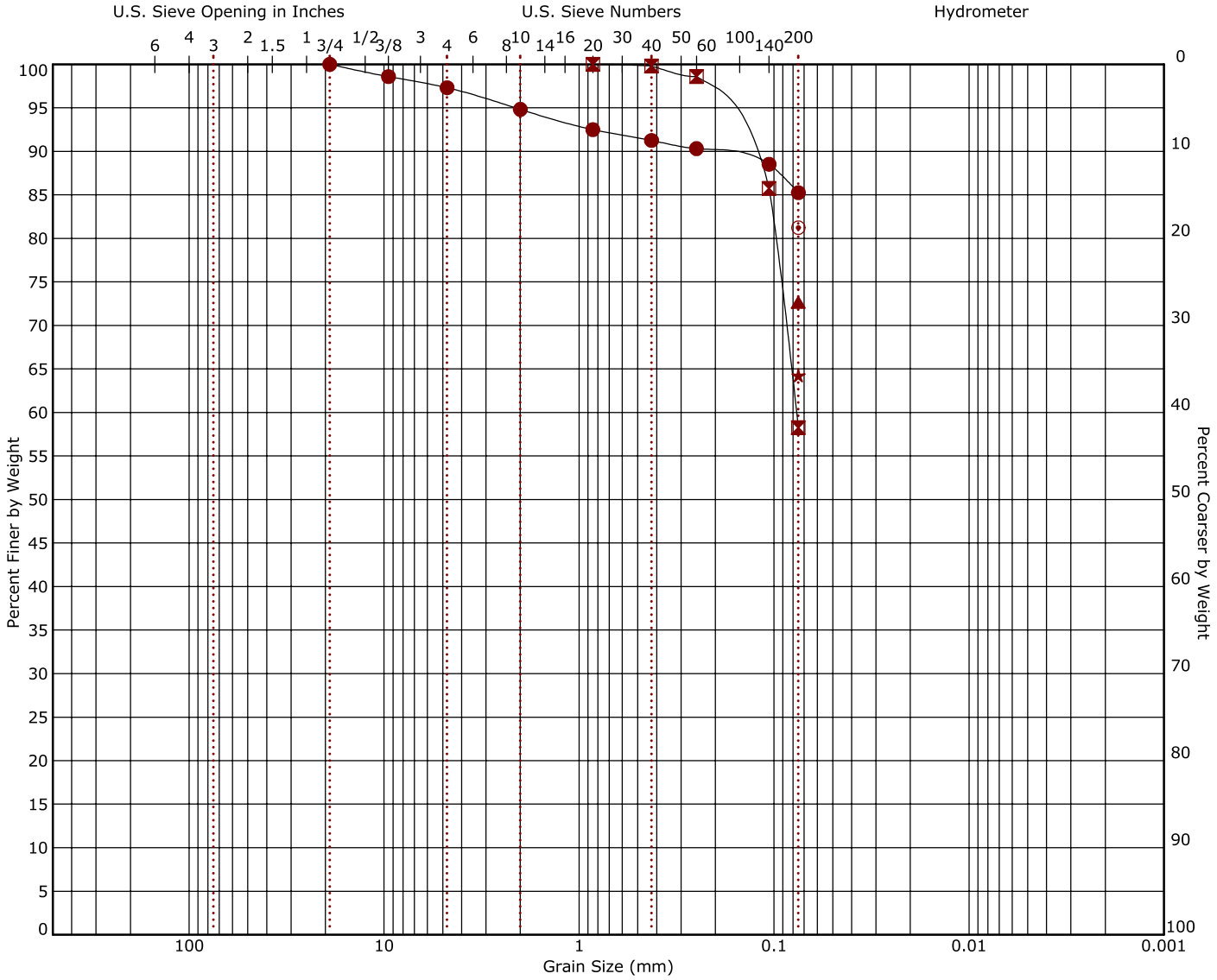
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-161	8.5 - 10	0.075							76.3		
⊠	B-162	5 - 6.5	0.075							82.8		
▲	B-163	0.5 - 2	0.075							81.2		
★	B-164	2 - 3.5	19				0.0	1.6	22.4	76.0		
⊙	B-164	6.5 - 8.5	9.5				0.0	0.6	11.1	88.3		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-165	2 - 3.5	LEAN CLAY		30	20	10		
⊠	B-166	0.5 - 2	SANDY SILT		NP	NP	NP		
▲	B-167	2 - 3.5	LEAN CLAY with SAND		26	16	10		
★	B-168	5 - 6.5	SANDY LEAN CLAY		28	17	11		
⊙	B-169	5 - 6.5	LEAN CLAY with SAND		37	15	22		

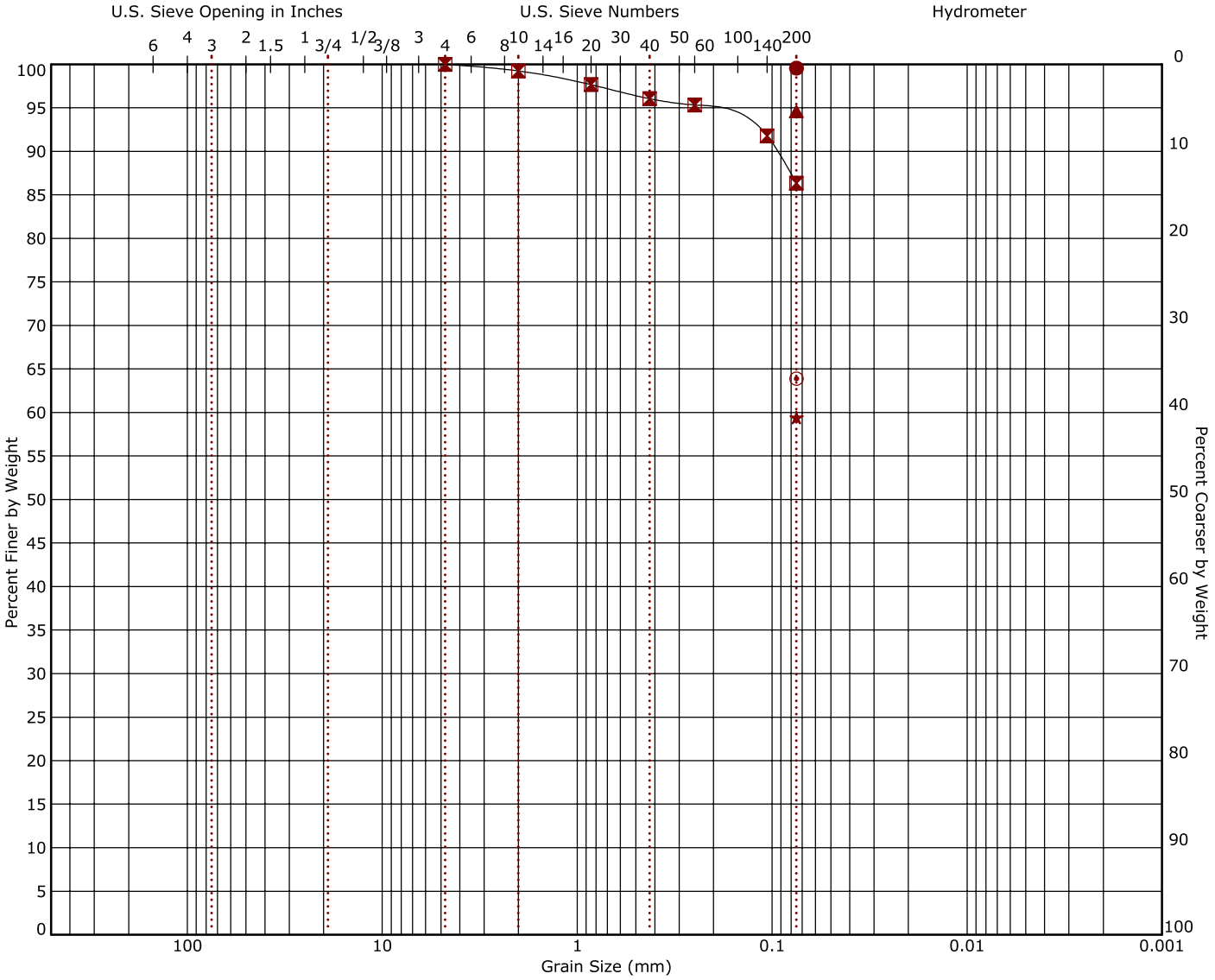
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-165	2 - 3.5	19				0.0	2.7	12.1	85.3		
⊠	B-166	0.5 - 2	0.85	0.077			0.0	0.0	41.7	58.3		
▲	B-167	2 - 3.5	0.075							72.7		
★	B-168	5 - 6.5	0.075							64.2		
⊙	B-169	5 - 6.5	0.075							81.2		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-170	3.5 - 5	LEAN CLAY		41	25	16		
⊠	B-171	2 - 3.5	LEAN CLAY		43	16	27		
▲	B-171	5 - 6.5	LEAN CLAY		36	17	19		
★	B-172	2 - 3.5	SANDY LEAN CLAY		41	15	26		
⊙	B-173	3.5 - 5	SANDY LEAN CLAY		30	14	16		

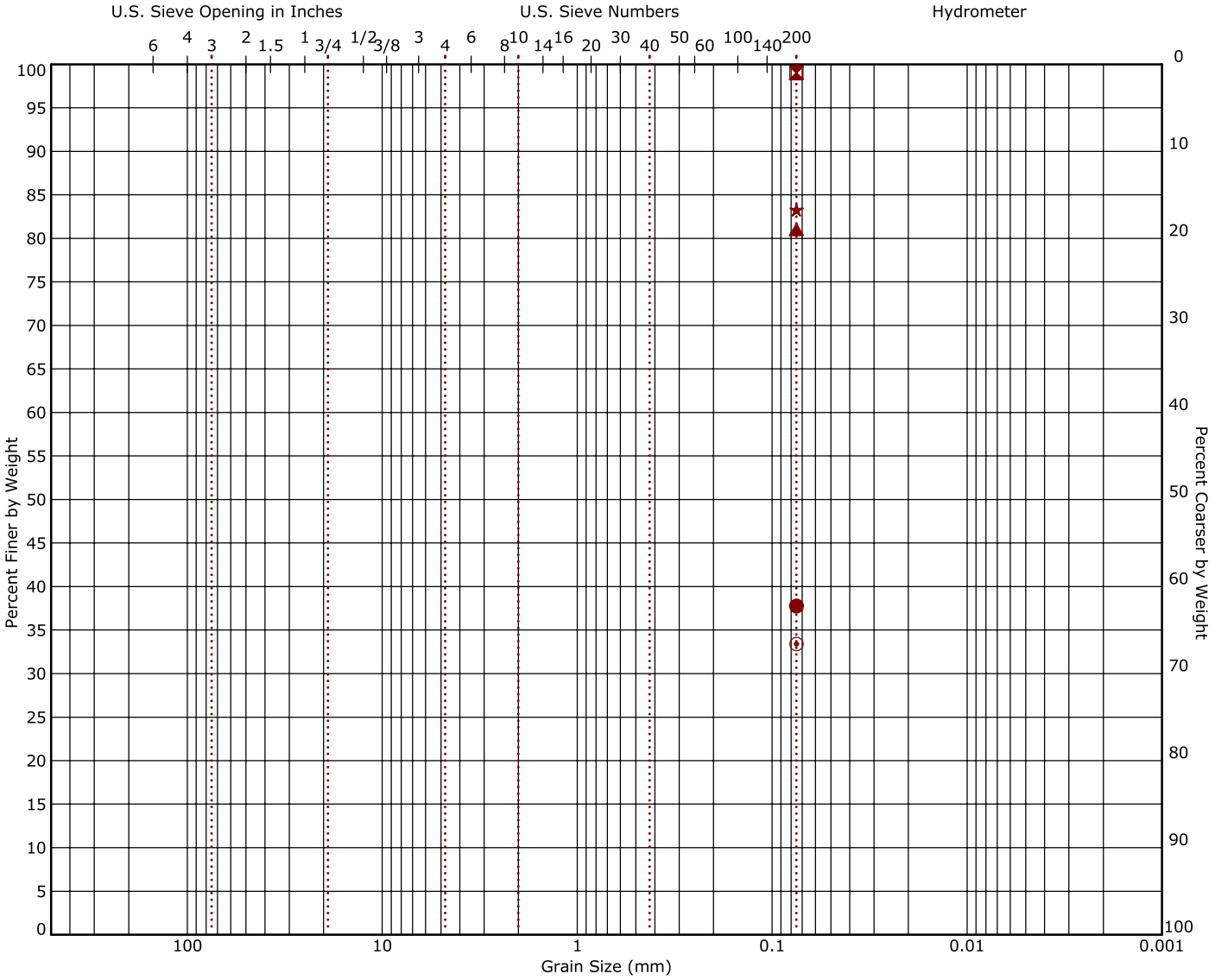
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-170	3.5 - 5	0.075							99.6		
⊠	B-171	2 - 3.5	4.75				0.0	0.0	13.7	86.3		
▲	B-171	5 - 6.5	0.075							94.6		
★	B-172	2 - 3.5	0.075							59.4		
⊙	B-173	3.5 - 5	0.075							63.9		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-176	0.5 - 2	SILTY SAND		NP	NP	NP		
⊠	B-178	8.5 - 10	LEAN CLAY		43	22	21		
▲	B-179	3.5 - 5							
★	B-180	2 - 3.5	LEAN CLAY with SAND		44	18	26		
⊙	B-181	0.5 - 2	SILTY SAND		NP	NP	NP		

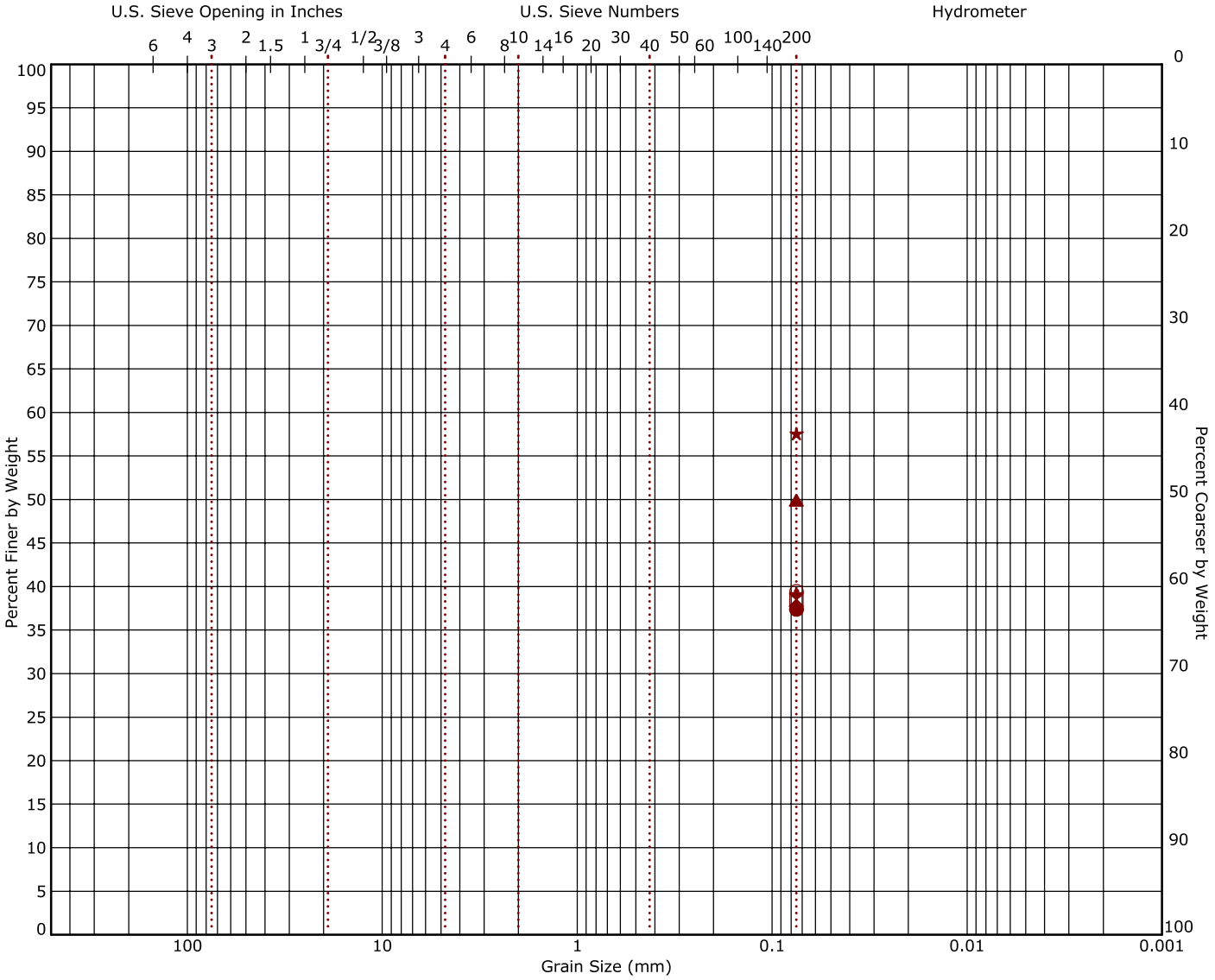
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-176	0.5 - 2	0.075							37.8		
⊠	B-178	8.5 - 10	0.075							99.0		
▲	B-179	3.5 - 5	0.075							81.0		
★	B-180	2 - 3.5	0.075							83.3		
⊙	B-181	0.5 - 2	0.075							33.4		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-183	0.5 - 2	SILTY SAND		NP	NP	NP		
⊠	B-185	2 - 3.5	SILTY SAND		NP	NP	NP		
▲	B-188	0.5 - 1.3	CLAYEY SAND		26	16	10		
★	B-189	2 - 3.5	SANDY SILT		NP	NP	NP		
⊙	B-190	0.5 - 2	SILTY SAND		NP	NP	NP		

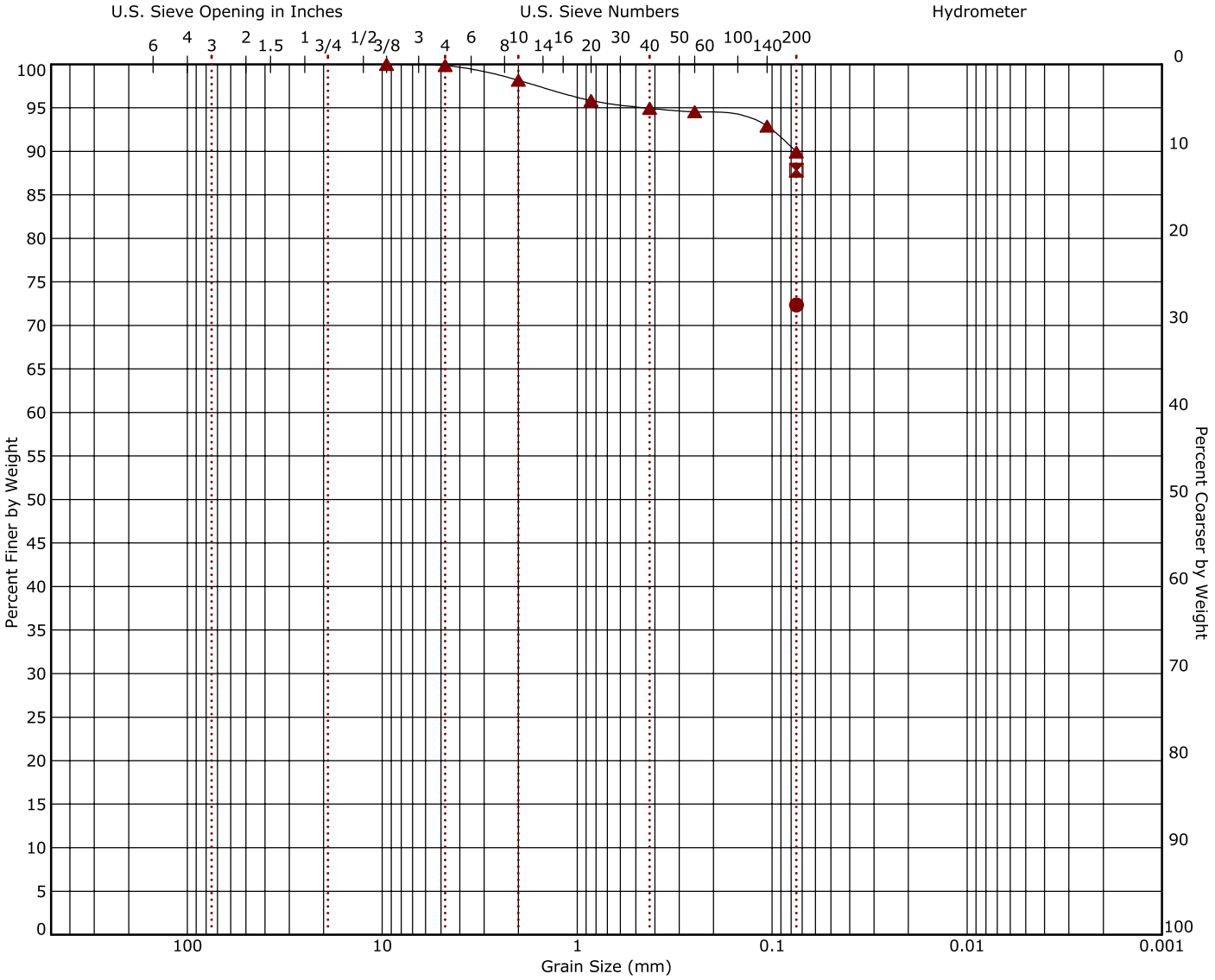
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-183	0.5 - 2	0.075							37.4		
⊠	B-185	2 - 3.5	0.075							38.5		
▲	B-188	0.5 - 1.3	0.075							49.9		
★	B-189	2 - 3.5	0.075							57.6		
⊙	B-190	0.5 - 2	0.075							39.5		

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-191	3.5 - 5	SILT with SAND		NP	NP	NP		
⊠	B-225	2 - 3.5	LEAN CLAY		47	19	28		
▲	B-225	6.5	FAT CLAY		59	15	44		

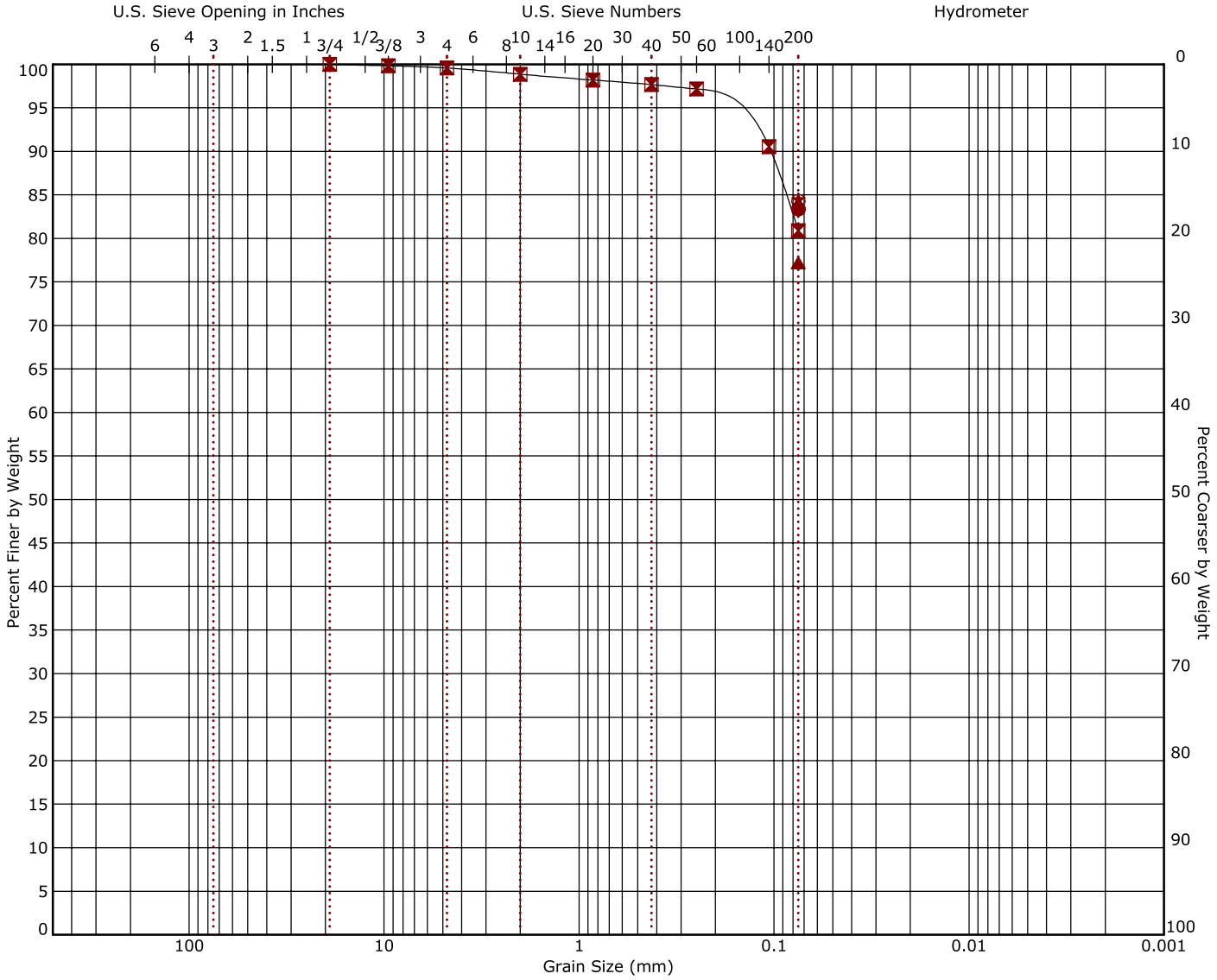
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-191	3.5 - 5	0.075							72.4		
⊠	B-225	2 - 3.5	0.075							87.8		
▲	B-225	6.5	9.5				0.0	0.1	10.0	89.9		

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-101	2 - 3.5	FAT CLAY with SAND		56	15	41		
⊠	B-101	5 - 5.6	LEAN CLAY with SAND		35	15	20		
▲	B-103	0.5 - 2	LEAN CLAY with SAND		33	19	14		
★	B-105	0.5 - 2	LEAN CLAY with SAND		31	21	10		
⊙	B-106	5 - 6.5	LEAN CLAY with SAND		30	19	11		

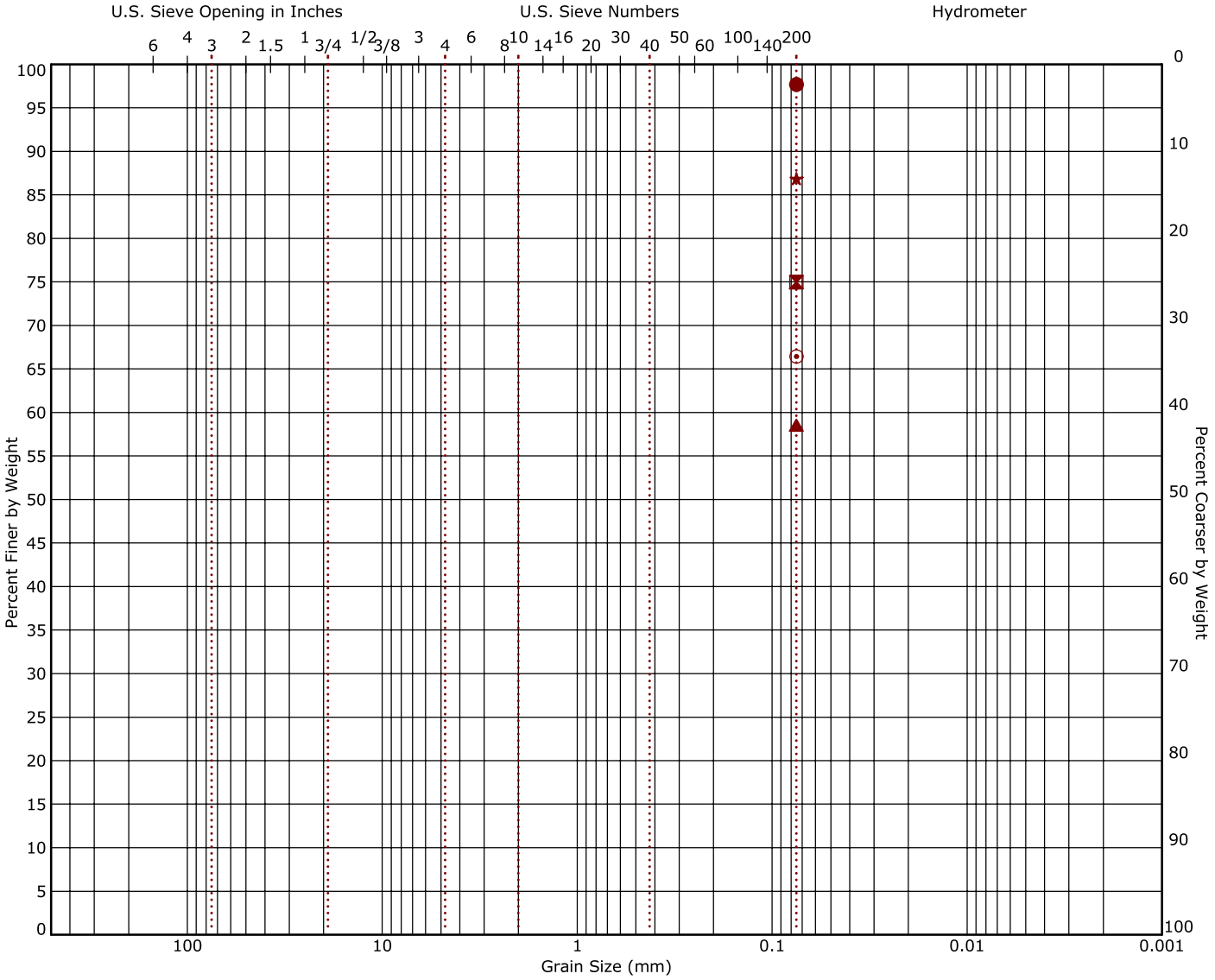
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-101	2 - 3.5	0.075							83.4		
⊠	B-101	5 - 5.6	19				0.0	0.4	18.7	80.9		
▲	B-103	0.5 - 2	0.075							77.2		
★	B-105	0.5 - 2	0.075							84.5		
⊙	B-106	5 - 6.5	0.075							84.3		

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-107	2 - 3.5	LEAN CLAY		32	16	16		
⊠	B-108A	3.5 - 5	LEAN CLAY with SAND		31	20	11		
▲	B-109	2 - 3.5	SANDY SILTY CLAY		26	19	7		
★	B-111A	3.5 - 5	LEAN CLAY		32	16	16		
⊙	B-112	0.5 - 2	SANDY LEAN CLAY		39	17	22		

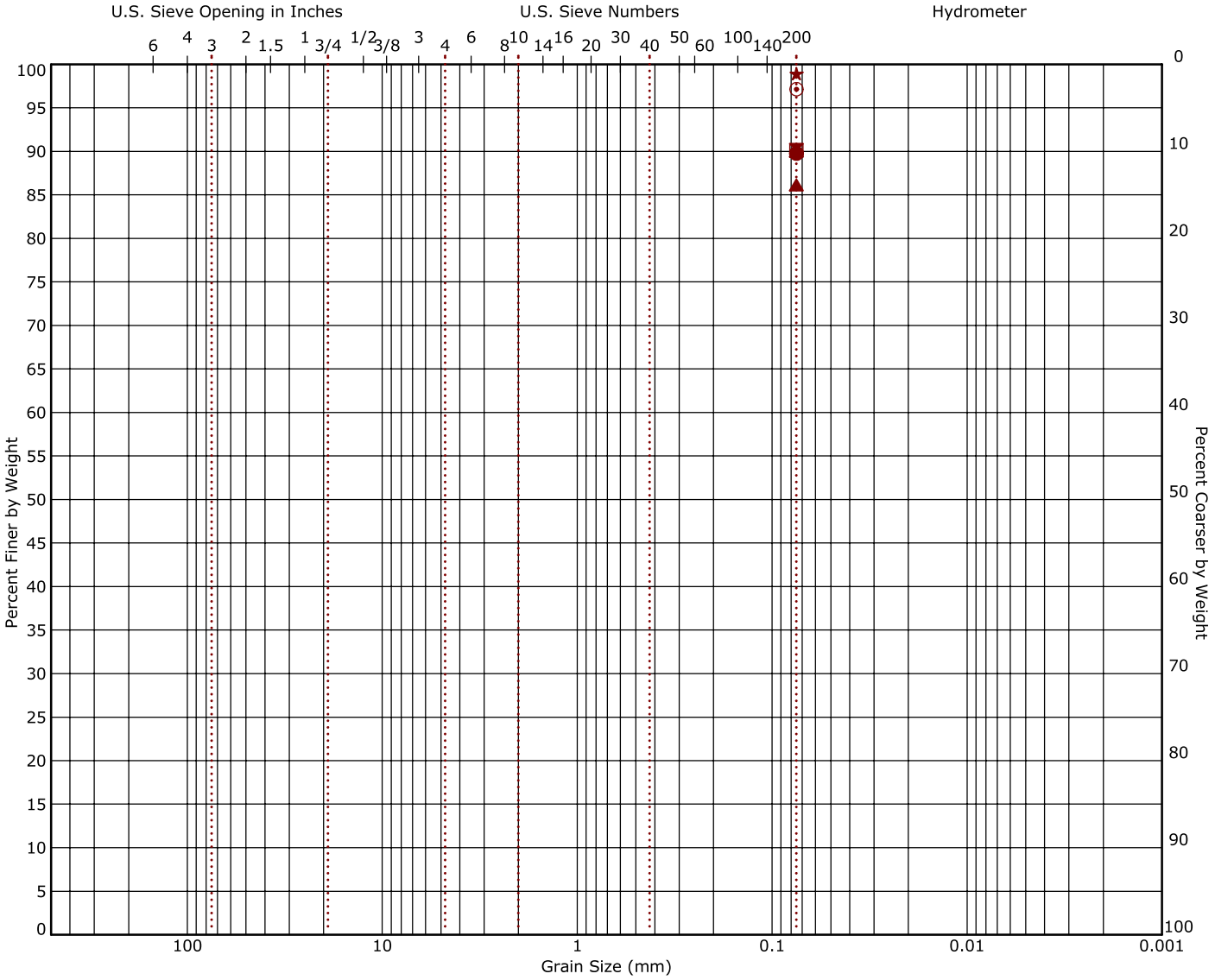
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-107	2 - 3.5	0.075							97.7		
⊠	B-108A	3.5 - 5	0.075							75.0		
▲	B-109	2 - 3.5	0.075							58.5		
★	B-111A	3.5 - 5	0.075							86.9		
⊙	B-112	0.5 - 2	0.075							66.4		

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID	Depth (Ft)	Description		LL	PL	PI	Cc	Cu
● B-113A	3.5 - 5	LEAN CLAY		31	18	13		
⊠ B-115A	5 - 6.5	LEAN CLAY		32	16	16		
▲ B-116A	2 - 3.5							
★ B-117	5 - 6.5	LEAN CLAY		36	18	18		
⊙ B-118	0.5 - 2	LEAN CLAY		32	20	12		

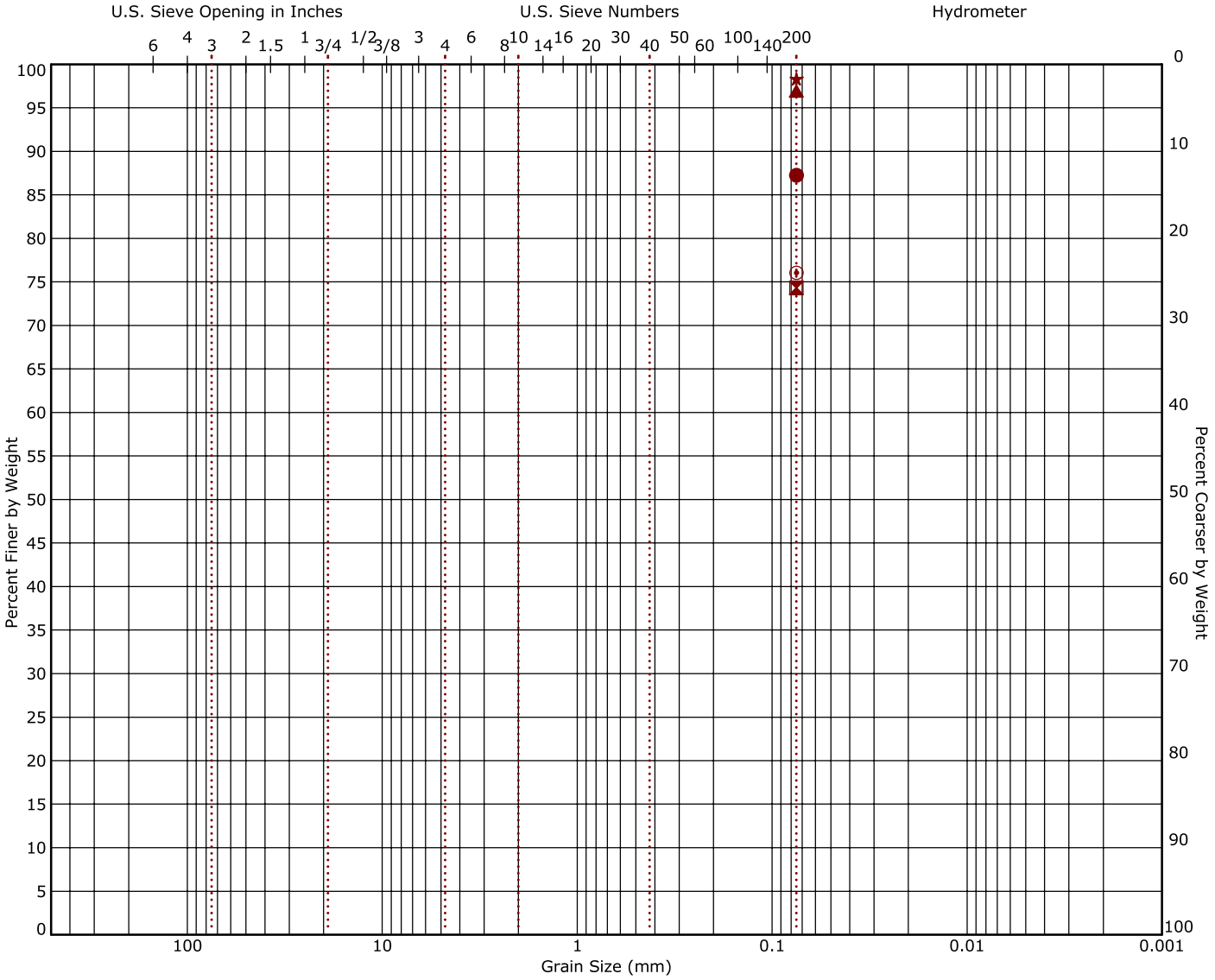
Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
● B-113A	3.5 - 5	0.075							89.8		
⊠ B-115A	5 - 6.5	0.075							90.1		
▲ B-116A	2 - 3.5	0.075							86.1		
★ B-117	5 - 6.5	0.075							98.9		
⊙ B-118	0.5 - 2	0.075							97.1		

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID	Depth (Ft)	Description		LL	PL	PI	Cc	Cu
● B-119	2 - 3.5	LEAN CLAY		32	16	16		
⊠ B-121A	5 - 6.5	LEAN CLAY with SAND		35	14	21		
▲ B-123	2 - 3.5	LEAN CLAY		37	24	13		
★ B-124A	0.5 - 2	LEAN CLAY		26	18	8		
⊙ B-125A	3.5 - 5	LEAN CLAY with SAND		36	15	21		

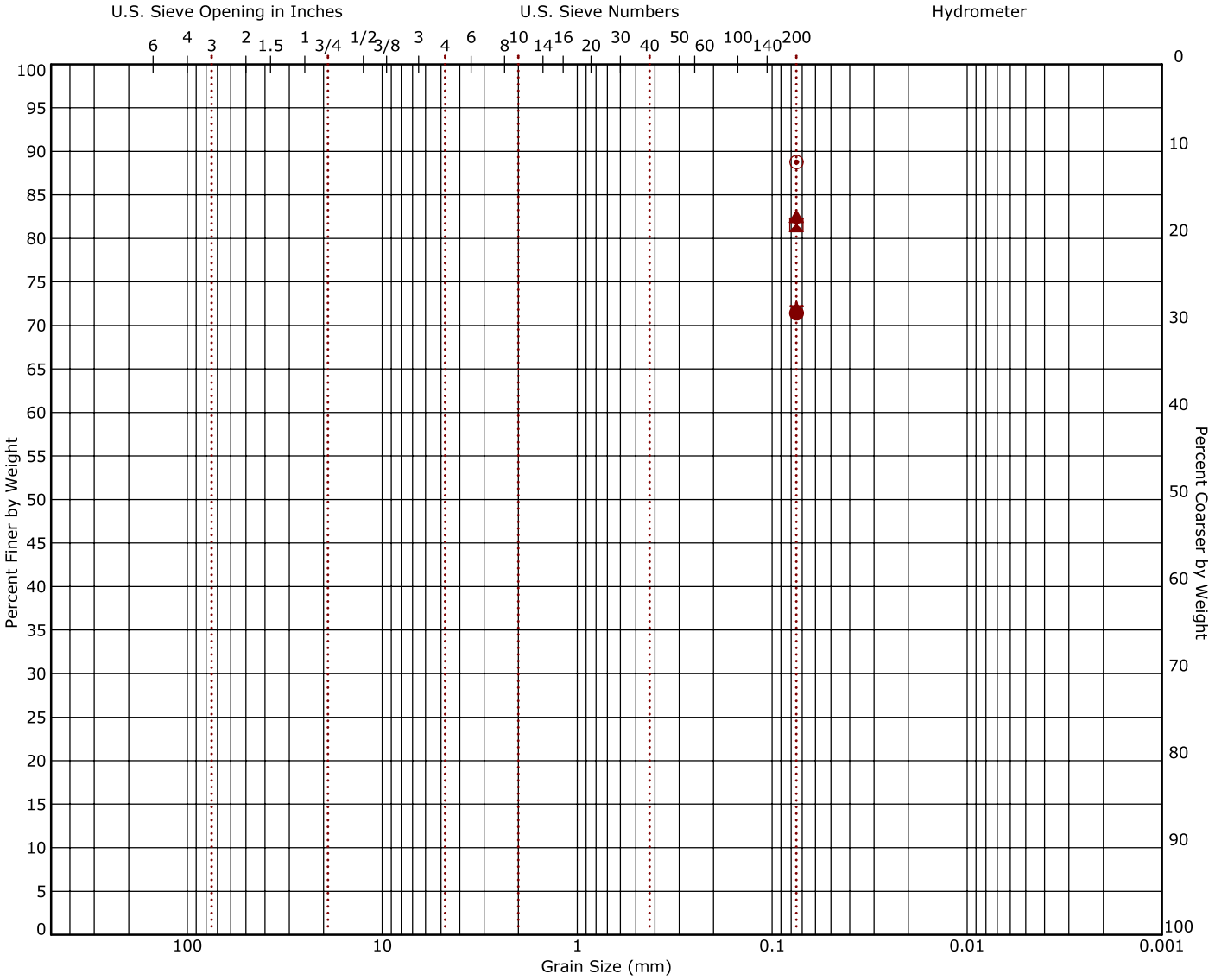
Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
● B-119	2 - 3.5	0.075							87.3		
⊠ B-121A	5 - 6.5	0.075							74.3		
▲ B-123	2 - 3.5	0.075							96.9		
★ B-124A	0.5 - 2	0.075							98.3		
⊙ B-125A	3.5 - 5	0.075							76.0		

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-126	2 - 3.5	LEAN CLAY with SAND		29	16	13		
⊠	B-127	2 - 3.5	LEAN CLAY with SAND		30	16	14		
▲	B-128	3.5 - 5	LEAN CLAY with SAND						
★	B-129	0.5 - 2	LEAN CLAY with SAND		29	18	11		
⊙	B-130	2 - 3.5	LEAN CLAY		30	18	12		

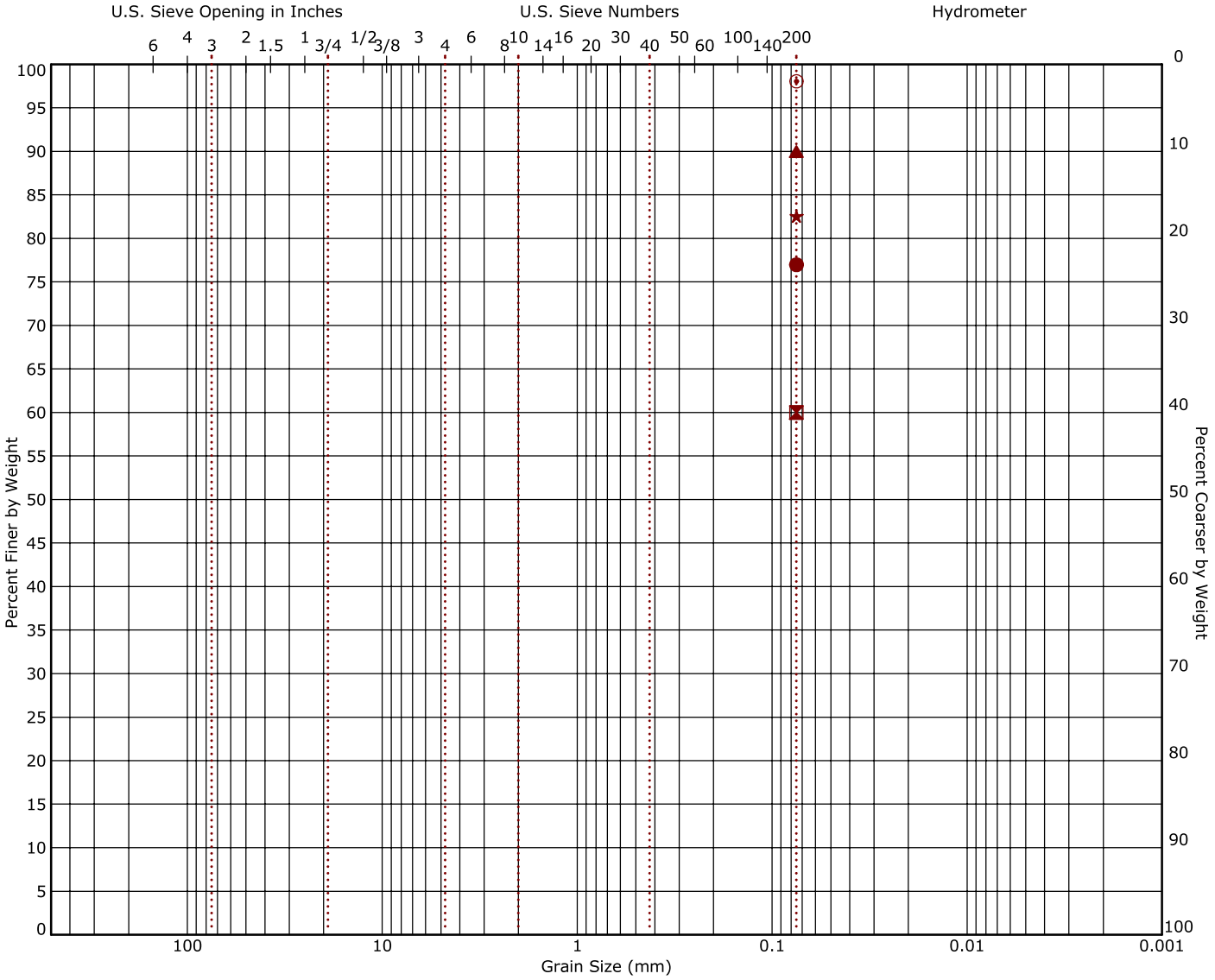
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-126	2 - 3.5	0.075							71.4		
⊠	B-127	2 - 3.5	0.075							81.6		
▲	B-128	3.5 - 5	0.075							82.5		
★	B-129	0.5 - 2	0.075							72.1		
⊙	B-130	2 - 3.5	0.075							88.8		

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-131	0.5 - 2	LEAN CLAY with SAND		41	17	24		
⊠	B-132	0.5 - 2	SANDY LEAN CLAY		30	18	12		
▲	B-133	2 - 3.5	LEAN CLAY		42	18	24		
★	B-134	3.5 - 5	LEAN CLAY with SAND		42	16	26		
⊙	B-135	8.5 - 10	LEAN CLAY		40	24	16		

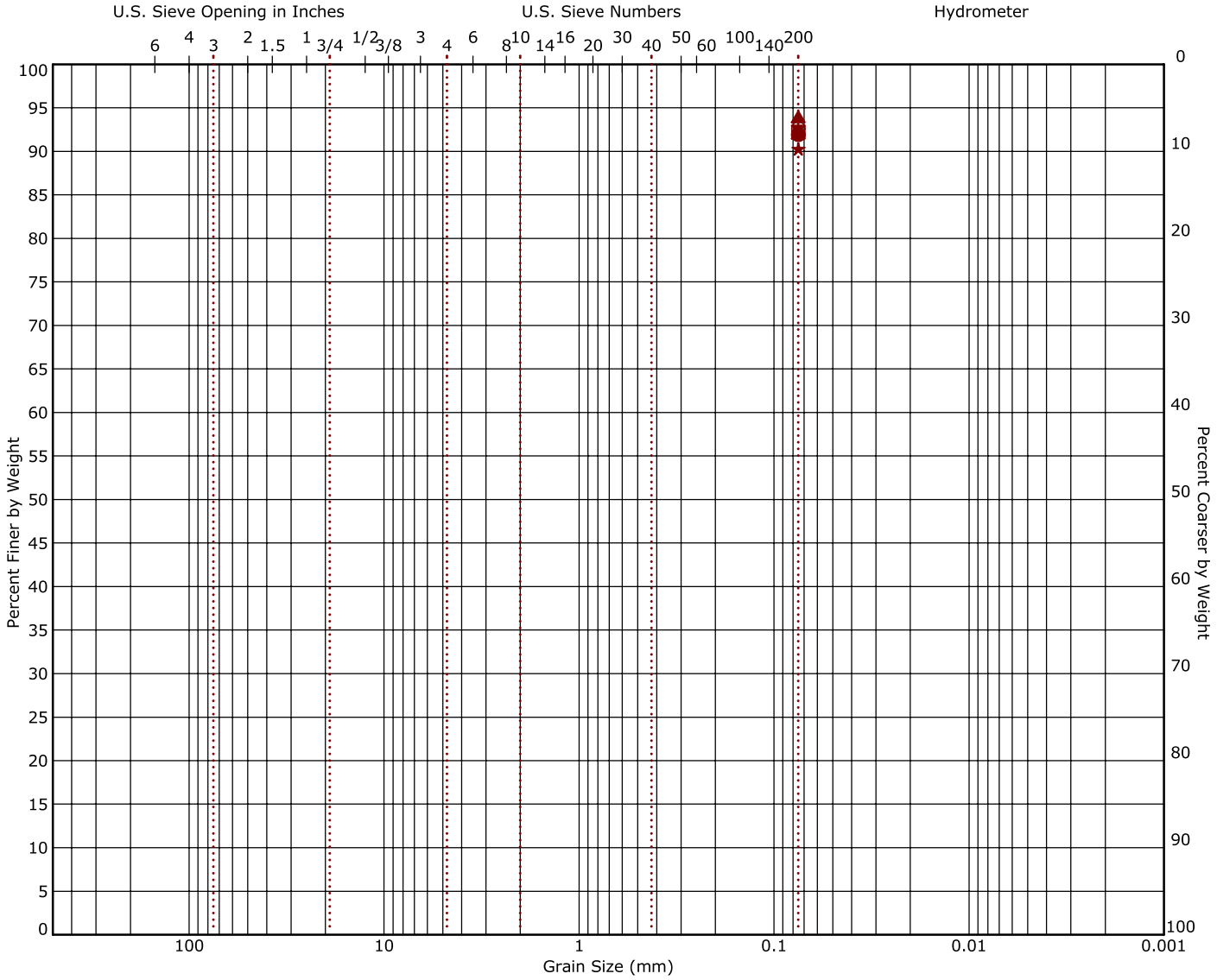
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-131	0.5 - 2	0.075							77.0		
⊠	B-132	0.5 - 2	0.075							60.0		
▲	B-133	2 - 3.5	0.075							90.0		
★	B-134	3.5 - 5	0.075							82.6		
⊙	B-135	8.5 - 10	0.075							98.1		

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-136	0.5 - 2	LEAN CLAY		31	19	12		
⊠	B-137	0.5 - 2	LEAN CLAY		30	18	12		
▲	B-140	5 - 6.5	LEAN CLAY		38	13	25		
★	B-142	2 - 3	LEAN CLAY		32	21	11		
⊙	B-145	5 - 6.5	LEAN CLAY		45	17	28		

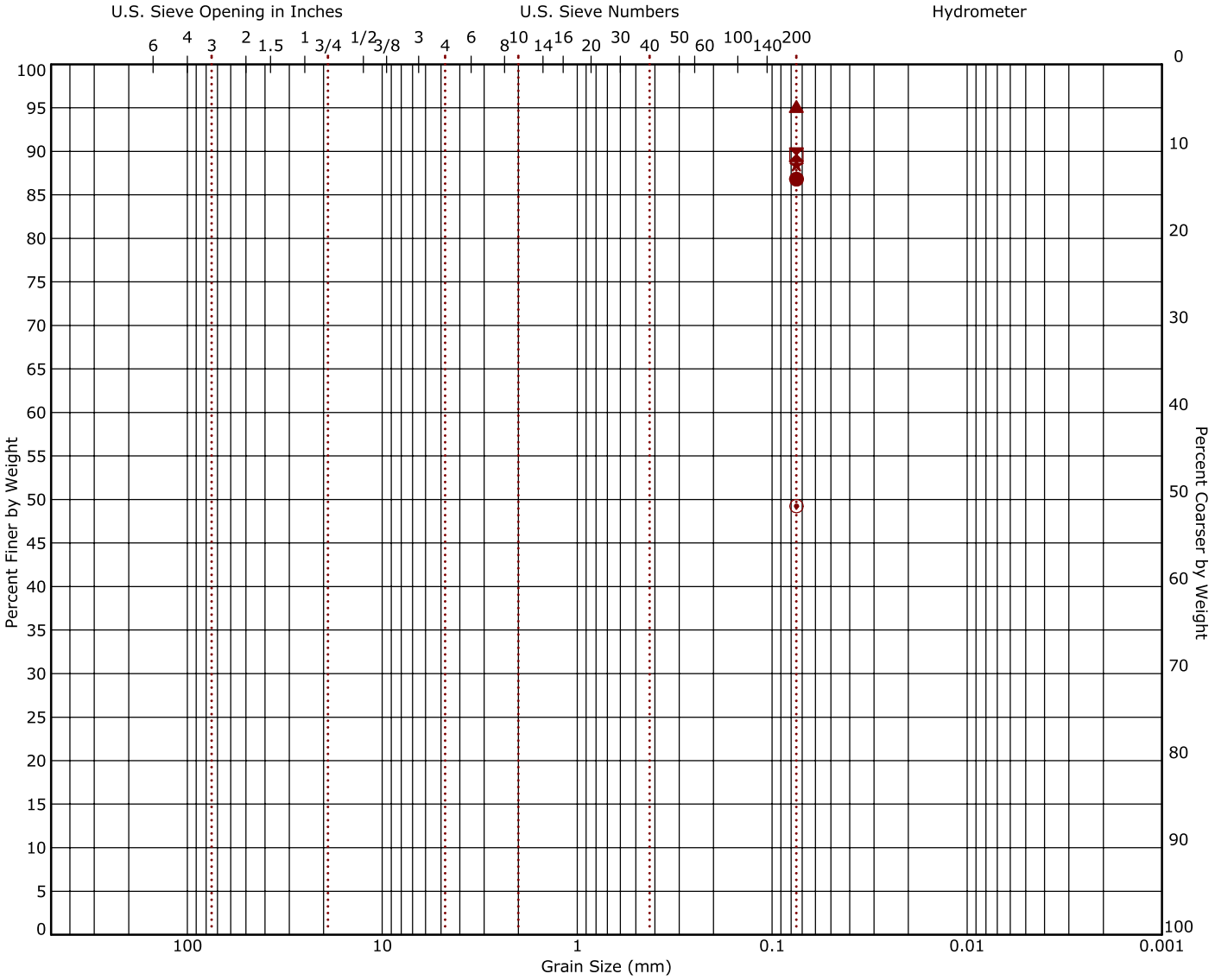
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-136	0.5 - 2	0.075							91.9		
⊠	B-137	0.5 - 2	0.075							92.2		
▲	B-140	5 - 6.5	0.075							94.0		
★	B-142	2 - 3	0.075							90.3		
⊙	B-145	5 - 6.5	0.075							92.6		

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-146	3.5 - 5	FAT CLAY		50	17	33		
⊠	B-148	3.5 - 5	LEAN CLAY		42	15	27		
▲	B-149	2 - 3.5	LEAN CLAY		47	22	25		
★	B-150	0.5 - 2	LEAN CLAY		49	15	34		
⊙	B-151	0.5 - 2	LEAN CLAY with SAND		NP	NP	NP		

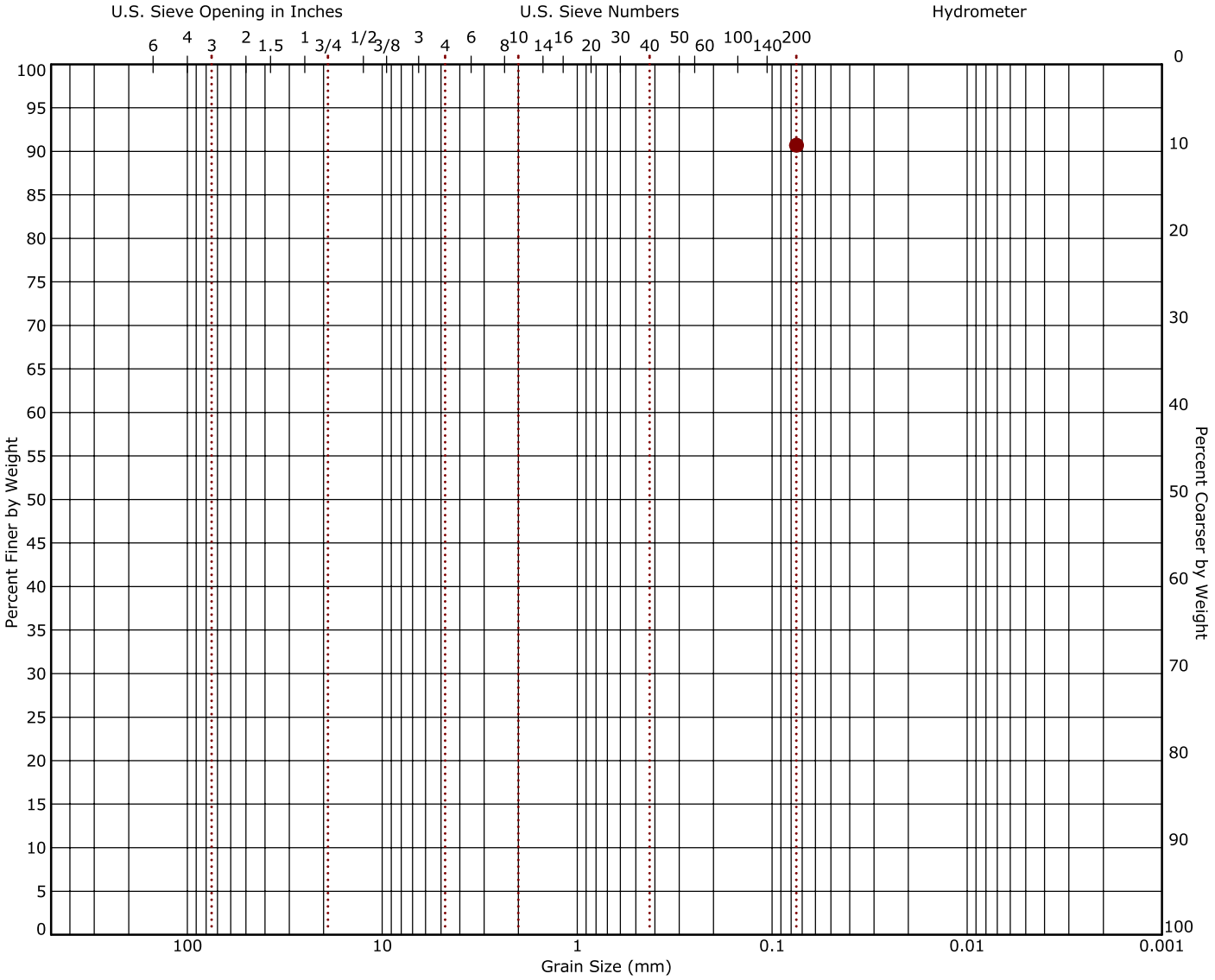
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-146	3.5 - 5	0.075							86.8		
⊠	B-148	3.5 - 5	0.075							89.6		
▲	B-149	2 - 3.5	0.075							95.2		
★	B-150	0.5 - 2	0.075							88.5		
⊙	B-151	0.5 - 2	0.075							49.2		

Project Clydesdale Design Level Geotech
E 76th Street N Owasso, OK | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID	Depth (Ft)	Description		LL	PL	PI	Cc	Cu
B-152	3.5 - 5	LEAN CLAY		32	16	16		

Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
B-152	3.5 - 5	0.075							90.7		

California Bearing Ratio Test (CBR)

4765 W Junction St
Springfield, MO 65802
(417) 864-5100

Client Name:	Kimley-Horn and Associates Inc	Project No.:	04255087	Date:	7/30/2025
Project Name:	Clydesdale Design Level Geotech				
Location:	E 76th Street N				
Boring Number	B-101				
Depth	5-7				
Sample Description:	Lean Clay with Sand				

Proctor Compaction Data:

Proctor Test Procedure:	D698	
Maximum Dry Density	107.7	pcf
Optimum Moisture Content	17.1	%
USCS Classification	CL	

CBR Specimen Compaction Data:

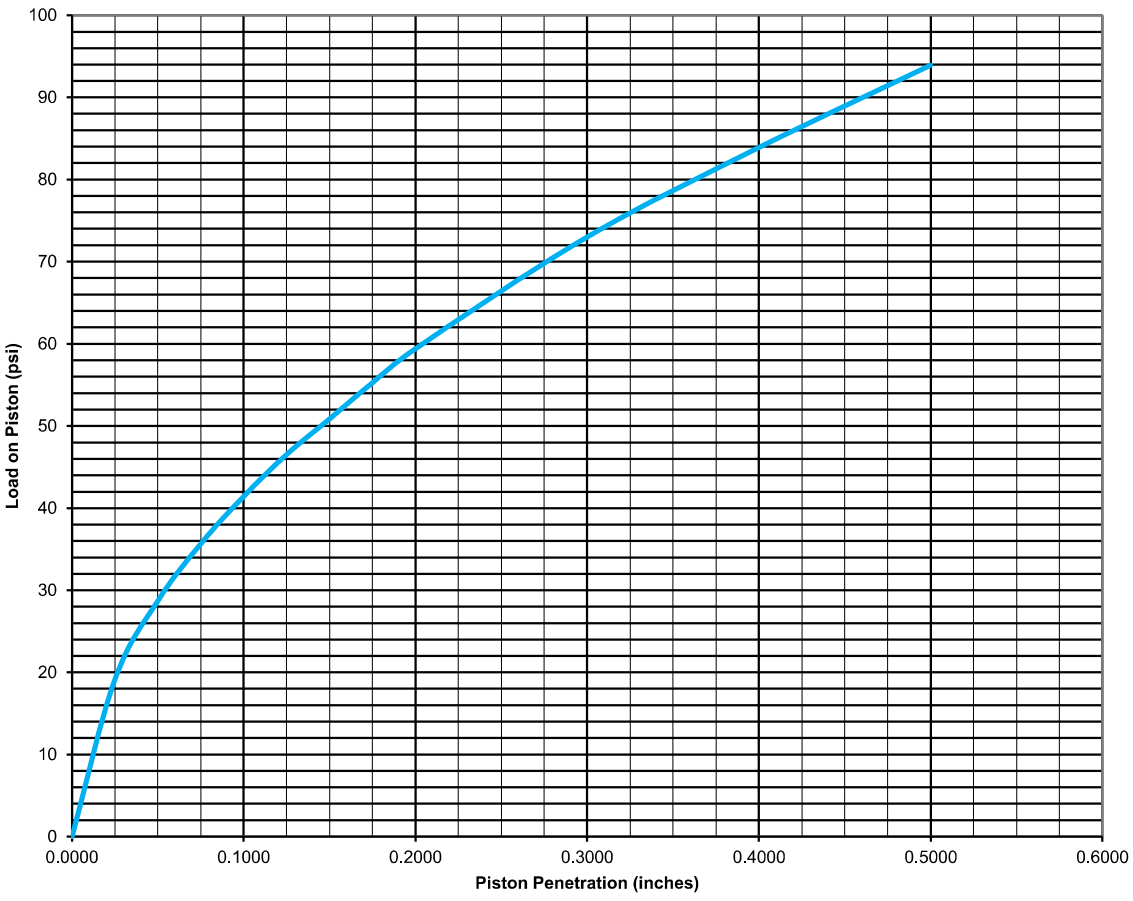
CBR Test Procedure:	ASTM D 1883	
Initial Moisture Content	18.2	%
Dry Density Before Soaking	107.4	pcf
Percent Compaction	99.7%	%
Moisture Content After Compactio	17.8	%
Dry Density After Soaking	107.7	pcf
Moisture Content After Soaking	18.8	%
CBR at 0.100 inches penetration	4.1	%
CBR at 0.200 inches penetration	4.0	%

Soil Index Properties:

Liquid Limit:	35	% Passing No. 200	81.0 %
Plasticity Index:	20		
Plastic Limit:	15		

Specimen Swell Data:

Surcharge Load	10	lb
Compaction	100.0	%
Swell (96 Hours)	0.29	%



California Bearing Ratio Test (CBR)

4765 W Junction St
Springfield, MO 65802
(417) 864-5100

Client Name:	Kimley-Horn and Associates Inc	Project No.:	04255087
Project Name:	Clydesdale Design Level Geotech	Date:	7/30/2025
Location:	E 76th Street N		
Boring Number	B-121		
Depth	5-7		
Sample Description:	Lean Clay		

Proctor Compaction Data:

Proctor Test Procedure:	D698	
Maximum Dry Density	112.2	pcf
Optimum Moisture Content	15.5	%
USCS Classification	CL	

CBR Specimen Compaction Data:

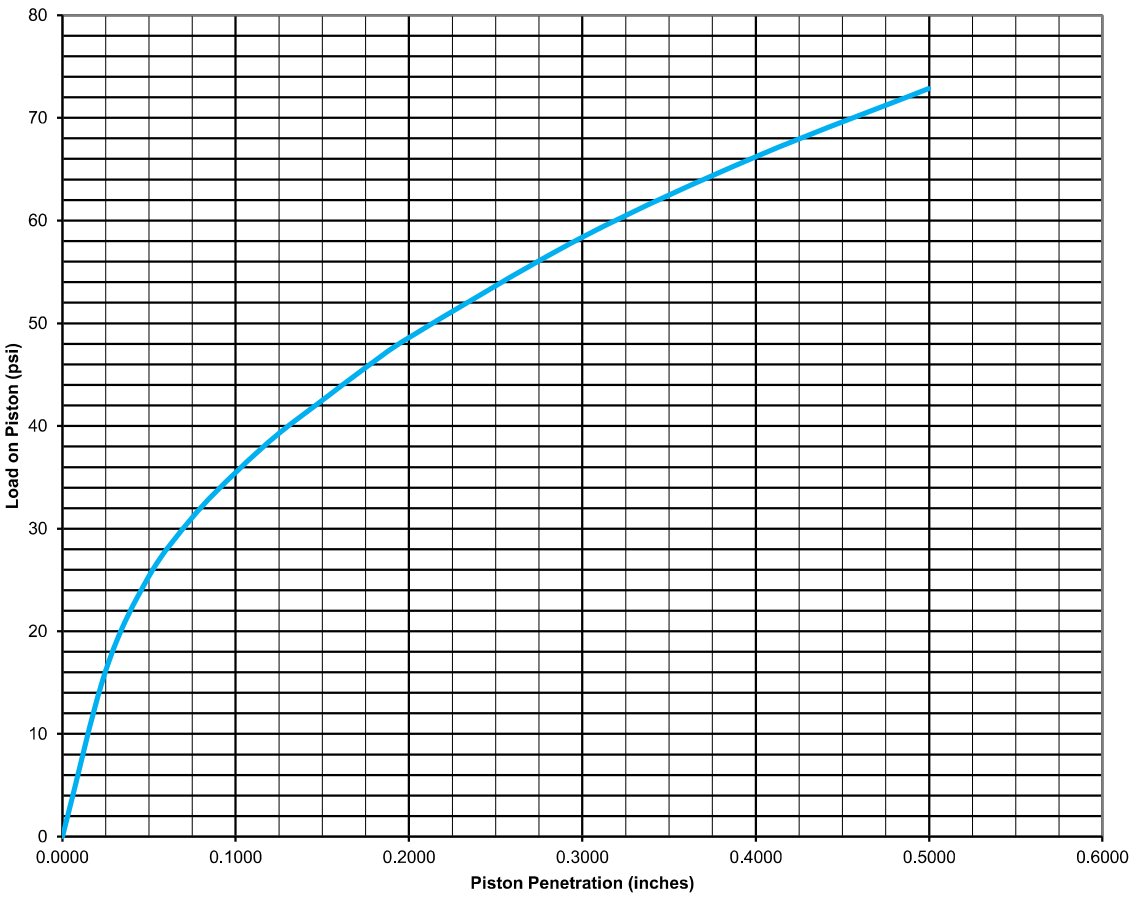
CBR Test Procedure:	ASTM D 1883	
Initial Moisture Content	15.5	%
Dry Density Before Soaking	111.2	pcf
Percent Compaction	99.1%	%
Moisture Content After Compactio	15.5	%
Dry Density After Soaking	110.1	pcf
Moisture Content After Soaking	17.7	%
CBR at 0.100 inches penetration	3.5	%
CBR at 0.200 inches penetration	3.2	%

Soil Index Properties:

Liquid Limit:	35	% Passing No. 200	87.0 %
Plasticity Index:	21		
Plastic Limit:	14		

Specimen Swell Data:

Surcharge Load	10	lb
Compaction	98.1	%
Swell (96 Hours)	1.24	%



California Bearing Ratio Test (CBR)

4765 W Junction St
Springfield, MO 65802
(417) 864-5100

Client Name:	Kimley-Horn and Associates Inc	Project No.:	04255087	Date:	7/30/2025
Project Name:	Clydesdale Design Level Geotech				
Location:	E 76th Street N				
Boring Number	B-140				
Depth	5-7				
Sample Description:	Lean Clay				

Proctor Compaction Data:

Proctor Test Procedure:	D698	
Maximum Dry Density	106.4	pcf
Optimum Moisture Content	18.2	%
USCS Classification	CL	

CBR Specimen Compaction Data:

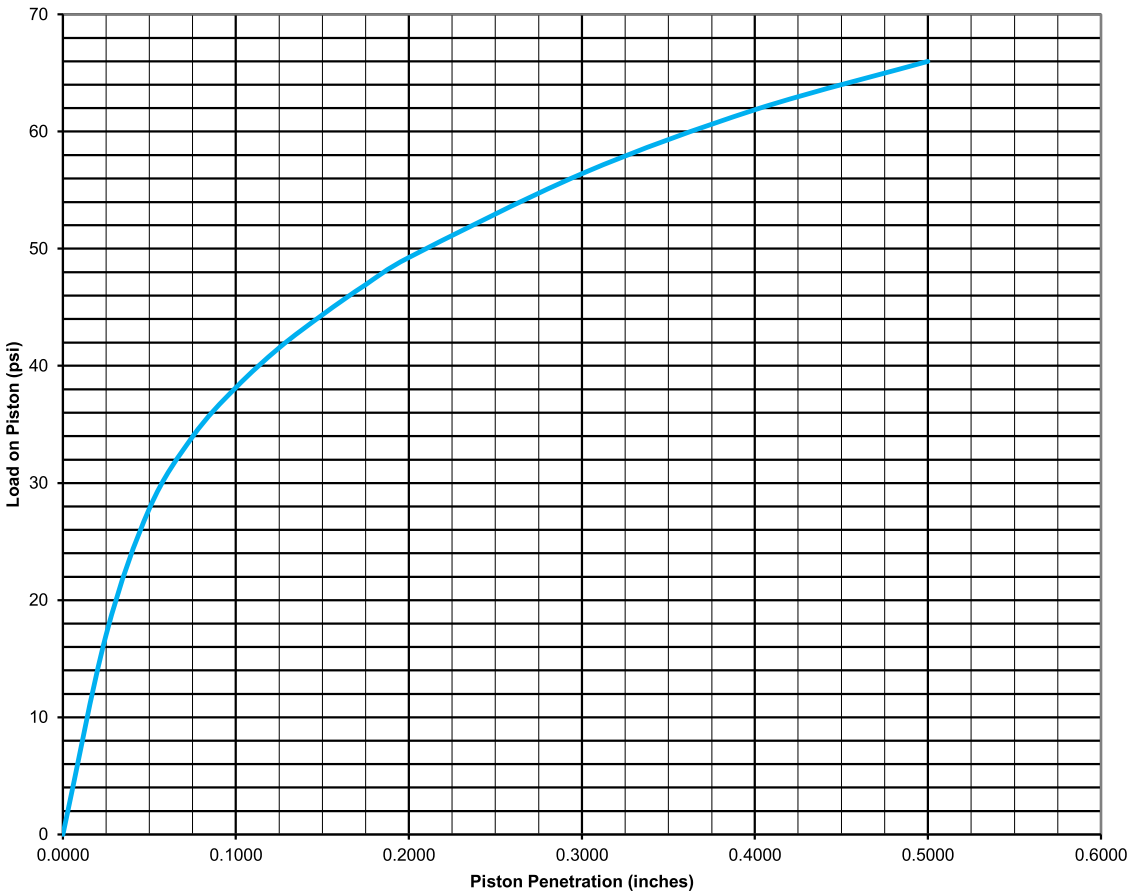
CBR Test Procedure:	ASTM D 1883	
Initial Moisture Content	17.7	%
Dry Density Before Soaking	107.1	pcf
Percent Compaction	100.7%	%
Moisture Content After Compactio	19.0	%
Dry Density After Soaking	107.4	pcf
Moisture Content After Soaking	18.3	%
CBR at 0.100 inches penetration	3.8	%
CBR at 0.200 inches penetration	3.3	%

Soil Index Properties:

Liquid Limit:	38	% Passing No. 200	91.0 %
Plasticity Index:	25		
Plastic Limit:	13		

Specimen Swell Data:

Surcharge Load	10	lb
Compaction	100.9	%
Swell (96 Hours)	0.51	%



California Bearing Ratio Test (CBR)

4765 W Junction St
Springfield, MO 65802
(417) 864-5100

Client Name:	Kimley-Horn and Associates Inc		Project No.:	04255087	Date: 7/15/2025
Project Name:	Project Clydesdale Design Level Geotech				
Location:	E 76th St N				
			Proctor Compaction Data:		
			Proctor Test Procedure:	D698	
Boring Number	B-200		Maximum Dry Density	96.7	pcf
Depth	1'-4'		Optimum Moisture Content	19.9	%
Sample Description:	Lean Clay; Brown		USCS Classification	CL	

CBR Specimen Compaction Data:

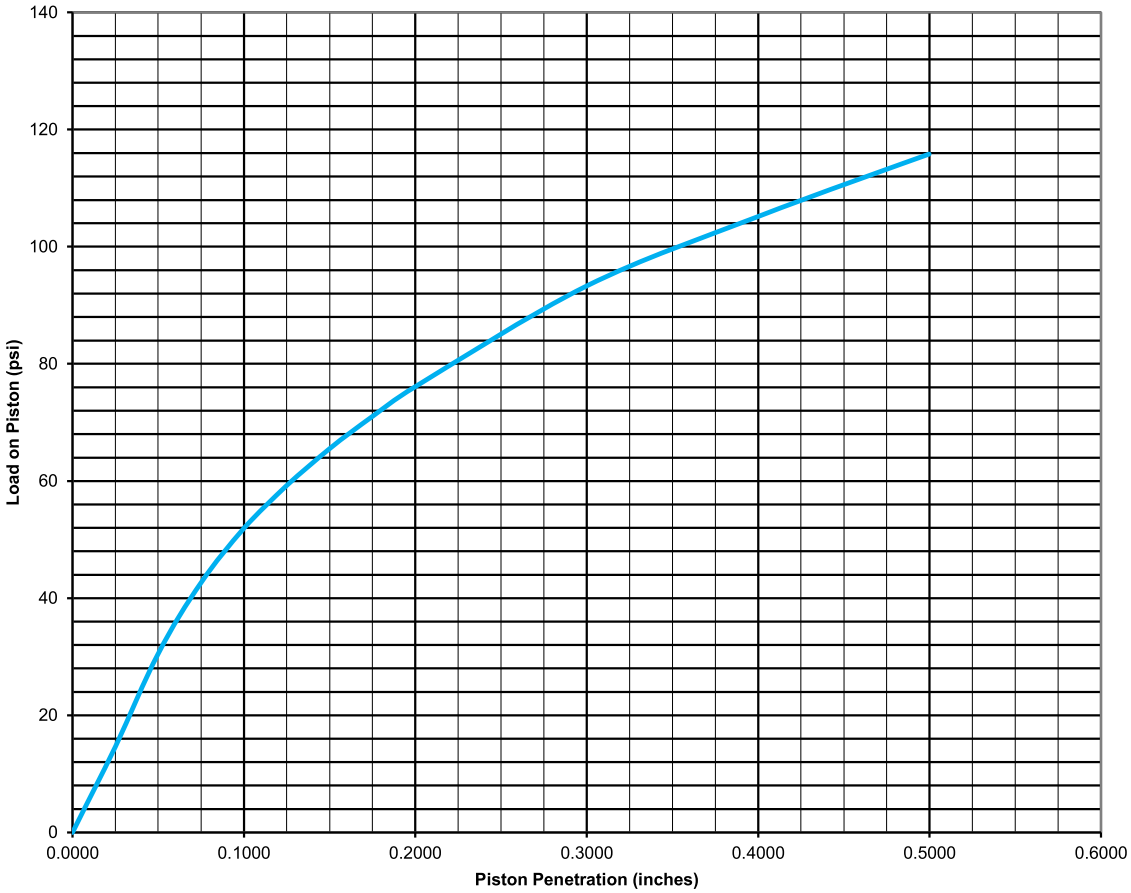
CBR Test Procedure:	ASTM D 1883	
Initial Moisture Content	21.0	%
Dry Density Before Soaking	98.3	pcf
Percent Compaction	101.6%	%
Moisture Content After Compactio	22.4	%
Dry Density After Soaking	99.3	pcf
Moisture Content After Soaking	21.5	%
CBR at 0.100 inches penetration	5.2	%
CBR at 0.200 inches penetration	5.1	%

Soil Index Properties:

Liquid Limit:	47	% Passing No. 200	90.4 %
Plasticity Index:	28		
Plastic Limit:	19		

Specimen Swell Data:

Surcharge Load	10	lb
Compaction	102.7	%
Swell (96 Hours)	1.27	%



California Bearing Ratio Test (CBR)

4765 W Junction St
Springfield, MO 65802
(417) 864-5100

Client Name:	Kimley-Horn and Associates Inc	Project No.:	04255087	Date:	8/13/2025
Project Name:	Clydesdale Design Level Geotech				
Location:	E 76th Street N				
Boring Number	B-171				
Depth	5-7				
Sample Description:	Lean Clay				

Proctor Compaction Data:

Proctor Test Procedure:	D698	
Maximum Dry Density	111.4	pcf
Optimum Moisture Content	16.2	%
USCS Classification	CL	

CBR Specimen Compaction Data:

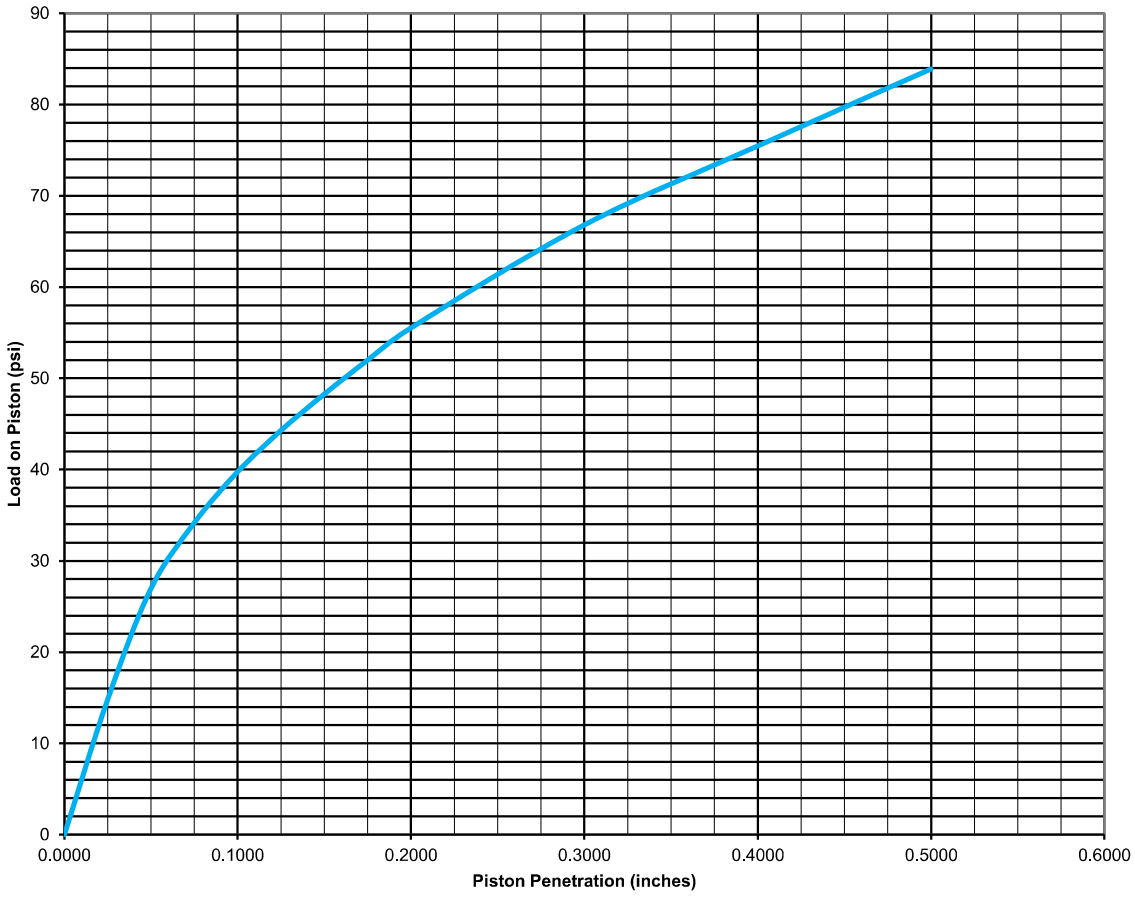
CBR Test Procedure:	ASTM D 1883	
Initial Moisture Content	17.2	%
Dry Density Before Soaking	110.6	pcf
Percent Compaction	99.3%	%
Moisture Content After Compactio	16.9	%
Dry Density After Soaking	110.2	pcf
Moisture Content After Soaking	18.8	%
CBR at 0.100 inches penetration	4.0	%
CBR at 0.200 inches penetration	3.7	%

Soil Index Properties:

Liquid Limit:	36	% Passing No. 200	95.0 %
Plasticity Index:	19		
Plastic Limit:	17		

Specimen Swell Data:

Surcharge Load	10	lb
Compaction	99.0	%
Swell (96 Hours)	1.34	%

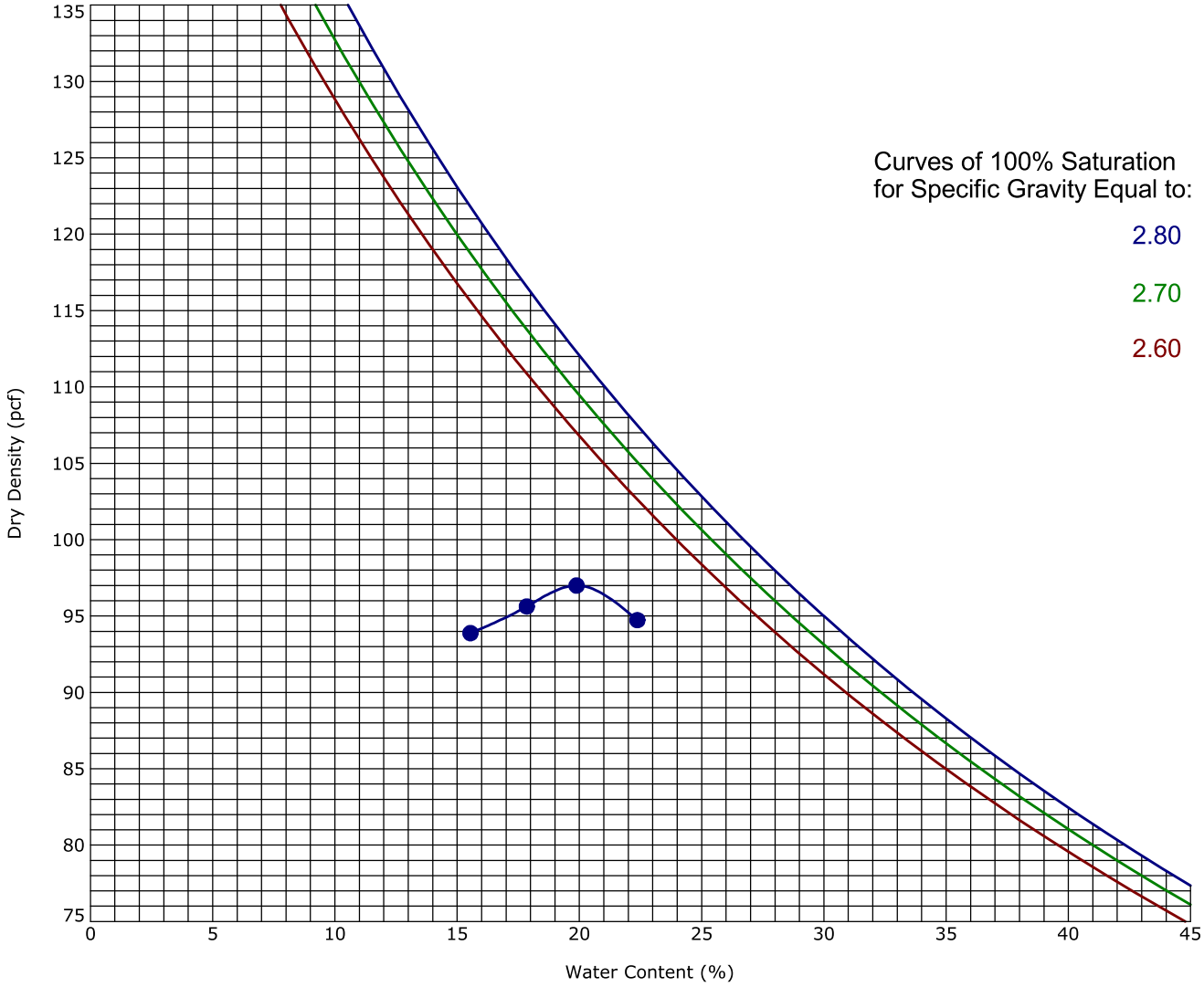


Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

9522 E 47th Pl, Ste D
Tulsa, OK

Moisture-Density Relationship

ASTM D698-Method A



	Boring ID	Depth (Ft)	Fines (%)	LL	PL	PI	Description of Materials
●	B-200	0	86	47	19	28	LEAN CLAY (CL)

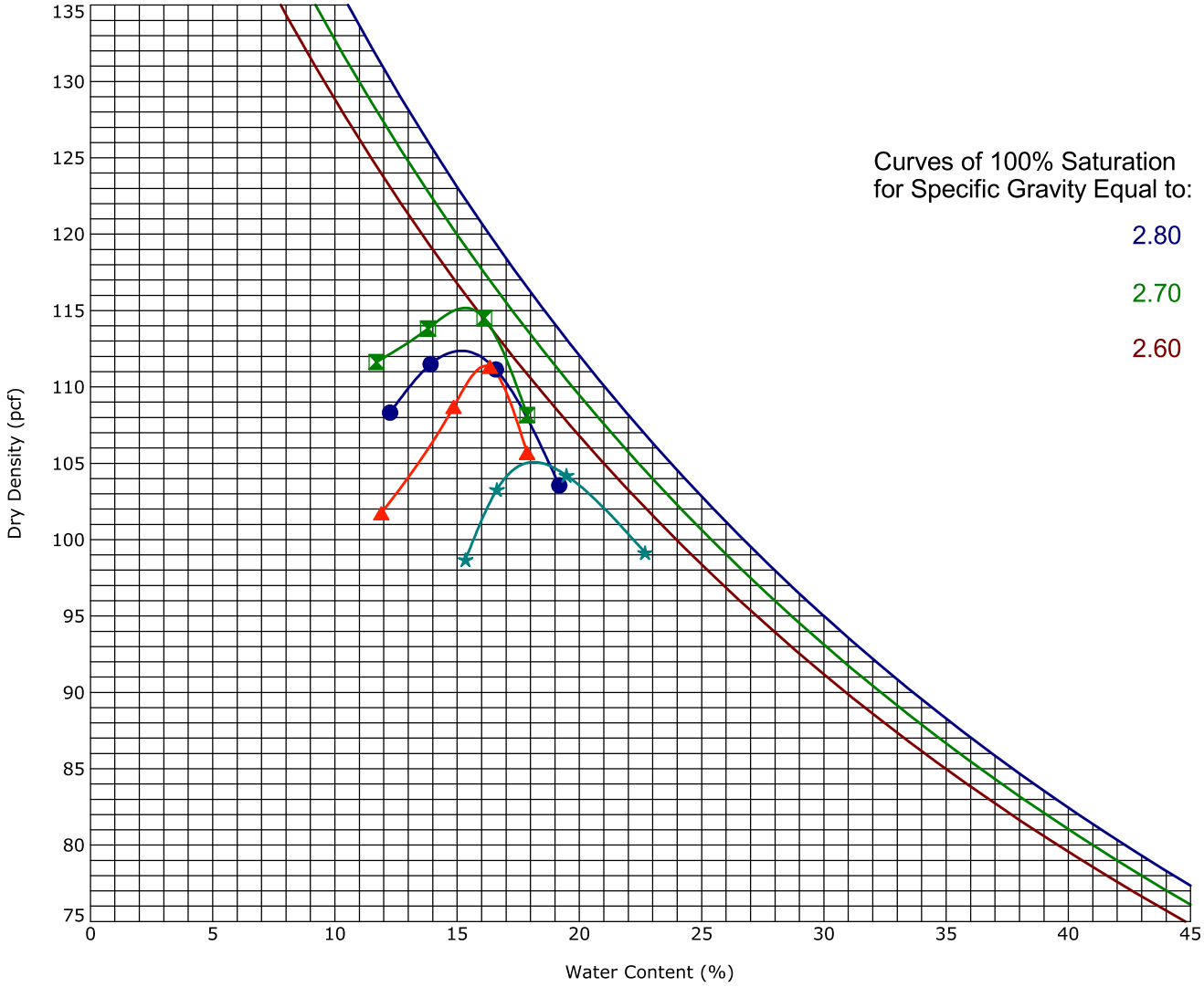
	Boring ID	Depth (Ft)	Test Method	Max DD (pcf)	Optimum WC (%)
●	B-200	0	ASTM D698-Method A	97.0	19.9

Project Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Moisture-Density Relationship

ASTM D698-Method A



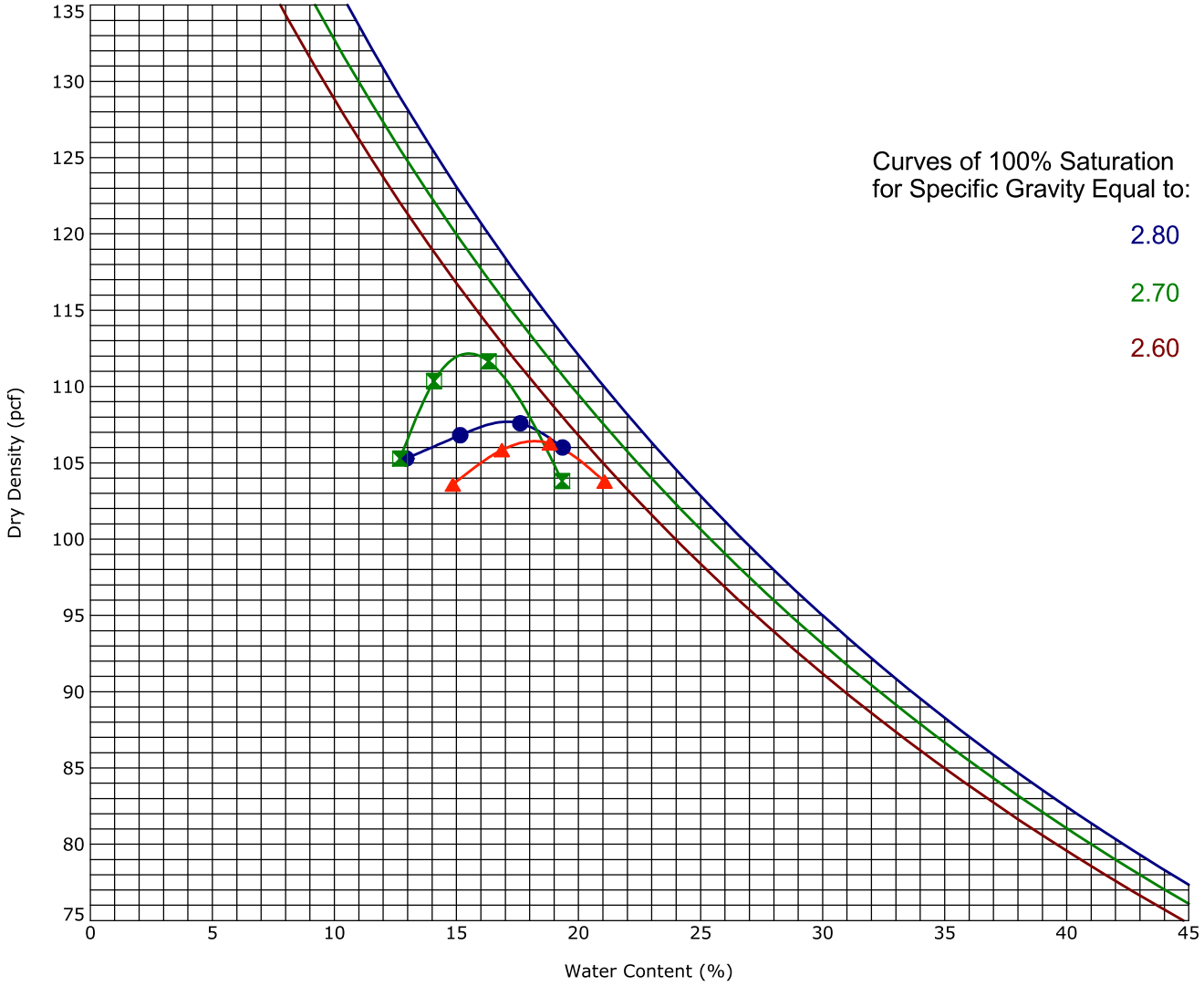
	Boring ID	Depth (Ft)	Fines (%)	LL	PL	PI	Description of Materials
●	B-164	2.5	76	30	15	15	LEAN CLAY with SAND (CL)
⊠	B-164	7.5 - 7.5	88	30	17	13	LEAN CLAY (CL)
▲	B-171	5	95	36	17	19	LEAN CLAY (CL)
★	B-225	7.5	90	59	15	44	FAT CLAY (CH)

	Boring ID	Depth (Ft)	Test Method	Max DD (pcf)	Optimum WC (%)
●	B-164	2.5	ASTM D698-Method A	112.4	15.2
⊠	B-164	7.5 - 7.5	ASTM D698-Method A	115.2	15.4
▲	B-171	5	ASTM D698-Method A	111.4	16.2
★	B-225	7.5	ASTM D698-Method A	105.1	18.1

9522 E 47th Pl, Ste D
Tulsa, OK

Moisture-Density Relationship

ASTM D698-Method A



	Boring ID	Depth (Ft)	Fines (%)	LL	PL	PI	Description of Materials
●	B-101	5 - 5	81	35	15	20	LEAN CLAY with SAND (CL)
⊠	B-121A	5	87	35	14	21	LEAN CLAY (CL)
▲	B-140	5	91	38	13	25	LEAN CLAY (CL)

	Boring ID	Depth (Ft)	Test Method	Max DD (pcf)	Optimum WC (%)
●	B-101	5 - 5	ASTM D698-Method A	107.7	17.1
⊠	B-121A	5	ASTM D698-Method A	112.2	15.5
▲	B-140	5	ASTM D698-Method A	106.4	18.2

Project

IOB - Project Clydesdale Design Level Geotech
B5255061

Date Received: 7/28/2025

Corrosivity Suite - *Results*

Sample Location		B-165	B-178	B-224
Sample Depth (ft.)		2.5-11.5	5'	5'
Acidity (pH)	**AASHTO T289**	6.1	8.9	6.2
Water Soluble Sulfate Ion Content (mg/Kg)	**ASTM C1580**	162	779	194
Water Soluble Sulfide Content (mg/Kg)	**AWWA 4500-S,D**	Nil	Nil	Nil
Water Soluble Chloride Ion Content (mg/Kg)	**ASTM D512**	35	185	42
Oxidation-Reduction Potential (RmV)	**ASTM G200**	243	227	337
Total Dissolved Salts (mg/Kg)	**AWWA 2520 B**	117	1460	366
Electrical Resistivity (Ω·cm)	**ASTM G57**	16000	1100	3000

Verified By: *Myles Warner*
8/13/2025

These tests were performed in general accordance with the applicable AASHTO, ASTM, and AWWA test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced without the full written consent of Terracon Consultants Inc.. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar materials.

Project

IOB - Project Clydesdale Design Level Geotech
B5255061

Date Received: 6/27/2025

Corrosivity Suite - *Results*

Sample Location		B - 196	B - 205	B - 218
Sample Depth (ft.)		5'	-	-
Acidity (pH)	**AASHTO T289**	5.4	7.7	5.7
Water Soluble Sulfate Ion Content (mg/Kg)	**ASTM C1580**	214	304	115
Water Soluble Sulfide Content (mg/Kg)	**AWWA 4500-S,D**	Nil	Nil	Nil
Water Soluble Chloride Ion Content (mg/Kg)	**ASTM D512**	26	40	47
Oxidation-Reduction Potential (RmV)	**ASTM G200**	135	129	149
Total Dissolved Salts (mg/Kg)	**AWWA 2520 B**	107	453	194
Electrical Resistivity (Ω·cm)	**ASTM G57**	8400	1400	2000

Verified By: *Myles Warner*
7/2/2025

These tests were performed in general accordance with the applicable AASHTO, ASTM, and AWWA test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced without the full written consent of Terracon Consultants Inc.. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar materials.

Project

IOB - Project Clydesdale Design Level Geotech
B5255061

Date Received: 8/11/2025

Corrosivity Suite - *Results*

Sample Location		B - 106	B - 122	B - 159
Sample Depth (ft.)		-	-	-
Acidity (pH)	**AASHTO T289**	8.8	8.1	8.8
Water Soluble Sulfate Ion Content (mg/Kg)	**ASTM C1580**	368	881	386
Water Soluble Sulfide Content (mg/Kg)	**AWWA 4500-S,D**	Nil	Nil	Nil
Water Soluble Chloride Ion Content (mg/Kg)	**ASTM D512**	24	160	120
Oxidation-Reduction Potential (RmV)	**ASTM G200**	285	292	218
Total Dissolved Salts (mg/Kg)	**AWWA 2520 B**	750	1150	600
Electrical Resistivity (Ω·cm)	**ASTM G57**	3100	1500	2400

Verified By: *Myles Warner*
8/19/2025

These tests were performed in general accordance with the applicable AASHTO, ASTM, and AWWA test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced without the full written consent of Terracon Consultants Inc.. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar materials.

Thermal Resistivity by Needle Point Probe - ASTM D5334

Report Date: 09/11/2025

70 Vantage Point Dr, Ste 1
Rochester, NY 14624

Project Name : Project Clydesdale Design Level Geotech
Project No. : 04255087
Client : Confidential

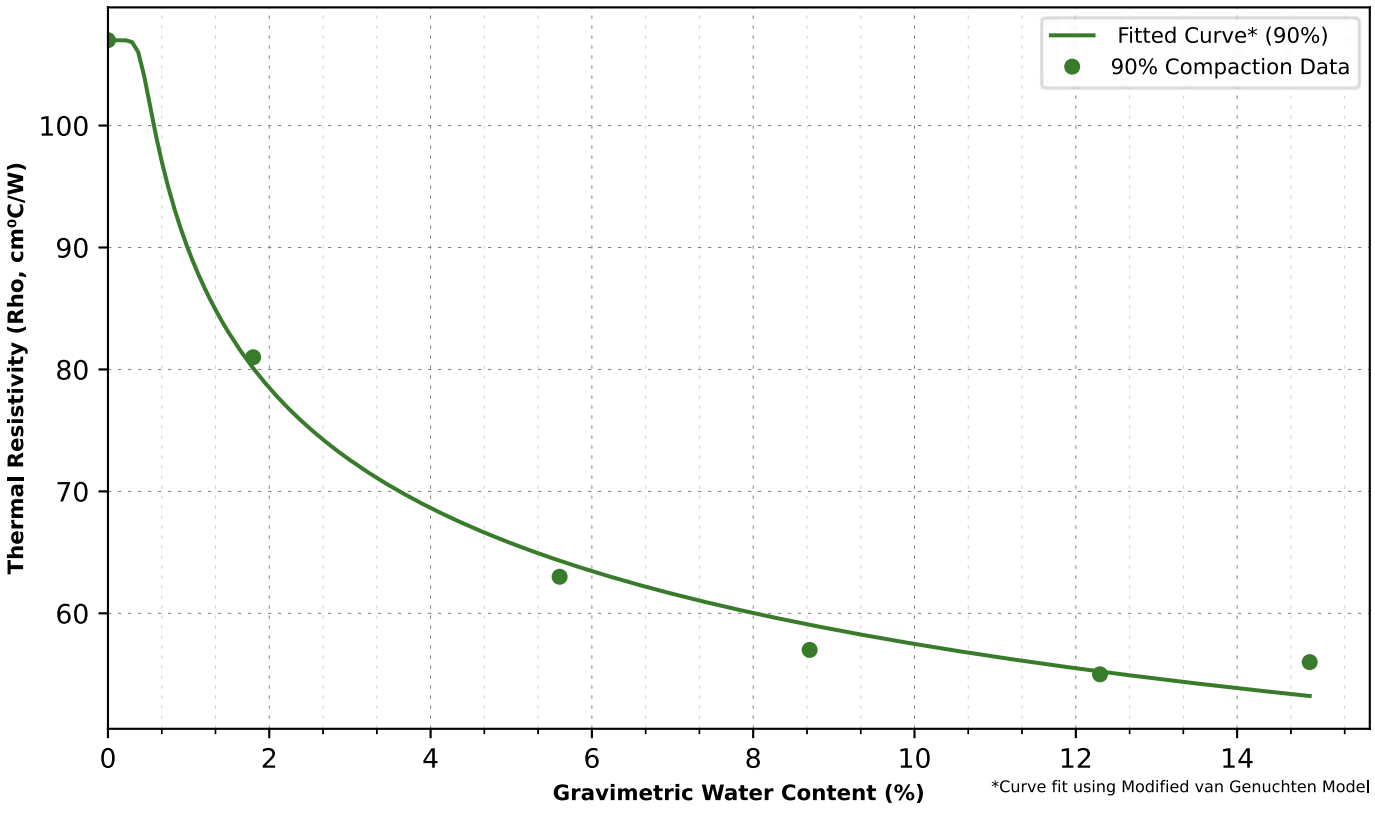
Location : B-164 @ 2.5'
Soil Description : Lean Clay
USCS Soil Classification : CL

Summary of Test Results

Method of Compaction : Standard Proctor
Maximum Dry Density : 112.4 pcf
Optimum Water Content : 15.2%
Density of Specimen : 101.2pcf @90%
TEMPOS Meter : Tempos : TEM00001839
Needle Used : TR-4: 4437
Needle Diameter/Length : 1.9mm/100mm
Method of Insertion : Pushed
Grease Used : Arctic MX-4

90% Compaction		
WC (%)	Thermal Resistivity (cm°C/W)	Test Temp (°C)
14.9	56	21.1
12.3	55	20.8
8.7	57	21.7
5.6	63	19.7
1.8	81	20.7
0.0	107	21.4

Thermal Characteristic Drying Curve



Application Version v02.17 | Produced by: Kyle Lemcke | SME by: Matthew Ridgway | Sample1_CompactionA

Thermal Resistivity by Needle Point Probe - ASTM D5334

Report Date: 09/11/2025

70 Vantage Point Dr, Ste 1
Rochester, NY 14624

Project Name : Project Clydesdale Design Level Geotech
Project No. : 04255087
Client : Confidential

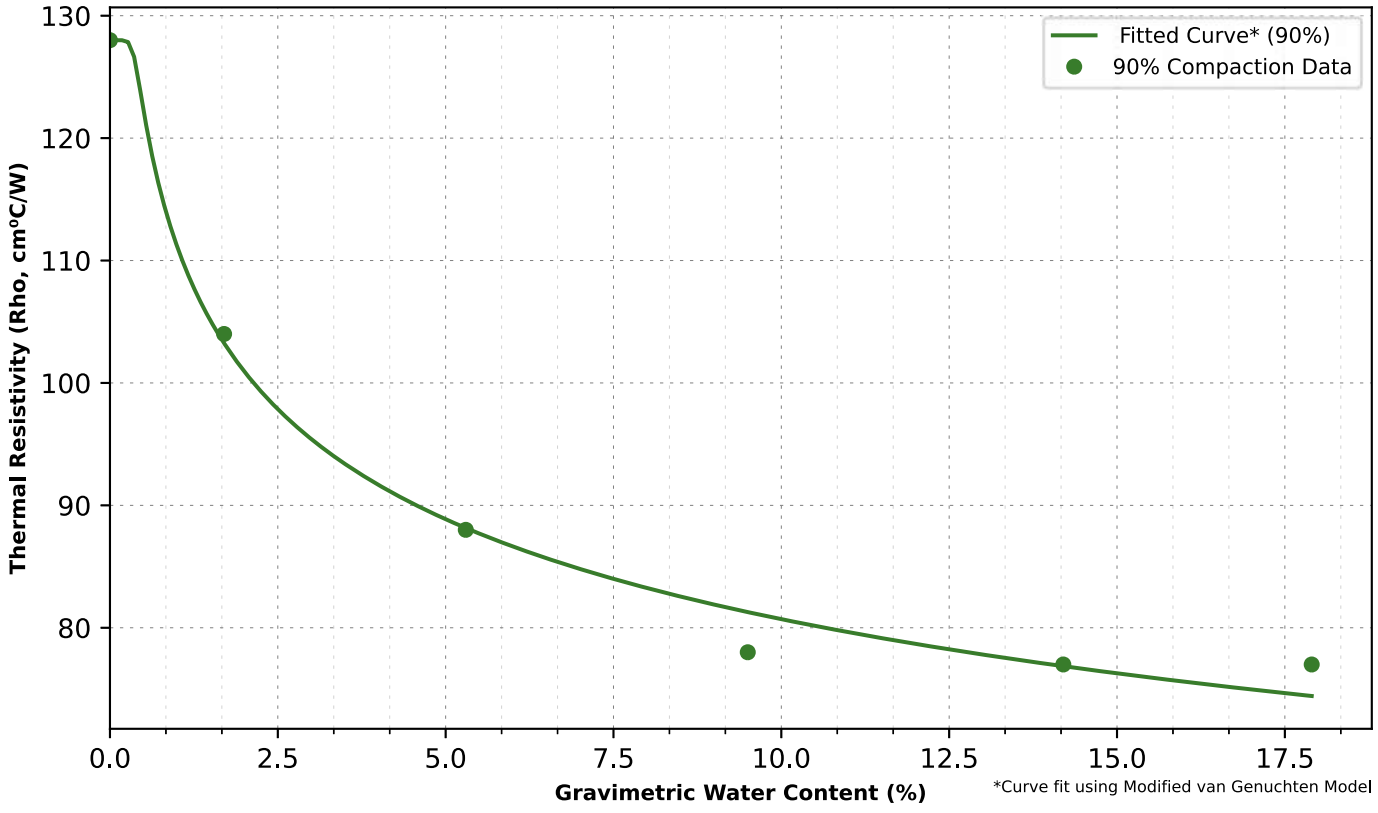
Location : B-225 @ 7.5'
Soil Description : Lean Clay
USCS Soil Classification : CL

Summary of Test Results

Method of Compaction : Standard Proctor
Maximum Dry Density : 105.1 pcf
Optimum Water Content : 18.1%
Density of Specimen : 94.6pcf @90%
TEMPOS Meter : Tempos : TEM00001839
Needle Used : TR-4: 4437
Needle Diameter/Length : 1.9mm/100mm
Method of Insertion : Pushed
Grease Used : Arctic MX-4

90% Compaction		
WC (%)	Thermal Resistivity (cm°C/W)	Test Temp (°C)
17.9	77	22.5
14.2	77	21.4
9.5	78	23.1
5.3	88	23.0
1.7	104	23.4
0.0	128	22.4

Thermal Characteristic Drying Curve



Application Version v02.17 | Produced by: Kyle Lemcke | SME by: Matthew Ridgway | Sample2_CompactionA

Thermal Resistivity by Needle Point Probe - ASTM D5334

Report Date: 09/11/2025

70 Vantage Point Dr, Ste 1
Rochester, NY 14624

Project Name : Project Clydesdale Design Level Geotech
Project No. : 04255087
Client : Confidential

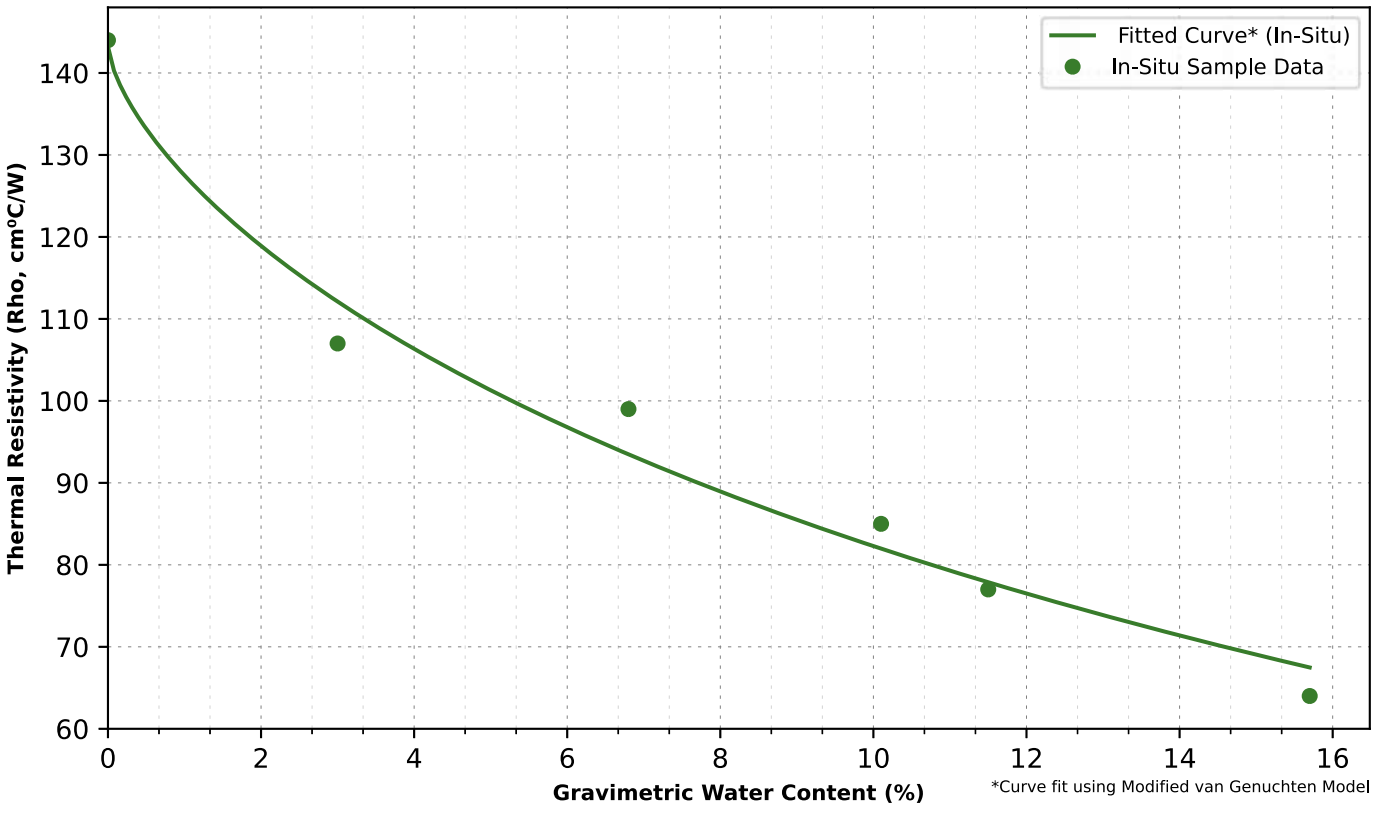
Location : B-119, 1'-3'
Soil Description : Lean Clay
USCS Soil Classification : CL

Summary of Test Results

TEMPOS Meter : Tempos : TEM00001839
Needle Used : TR-4: 4437
Needle Diameter/Length : 1.9mm/100mm
Method of Insertion : Pushed
Grease Used : Arctic MX-4

In-Situ Sample		
WC (%)	Thermal Resistivity (cm°C/W)	Test Temp (°C)
15.7	64	21.4
11.5	77	22.0
10.1	85	22.0
6.8	99	21.0
3.0	107	21.4
0.0	144	20.9

Thermal Characteristic Drying Curve



*Curve fit using Modified van Genuchten Model

Application Version v02.17 | Produced by: Kyle Lemcke | SME by: Matthew Ridgway | Sample1_CompactionA

Thermal Resistivity by Needle Point Probe - ASTM D5334

70 Vantage Point Dr, Ste 1
Rochester, NY 14624

Report Date: 09/12/2025

Project Name : Project Clydesdale Design Level Geotech
Project No. : 04255087
Client : Confidential

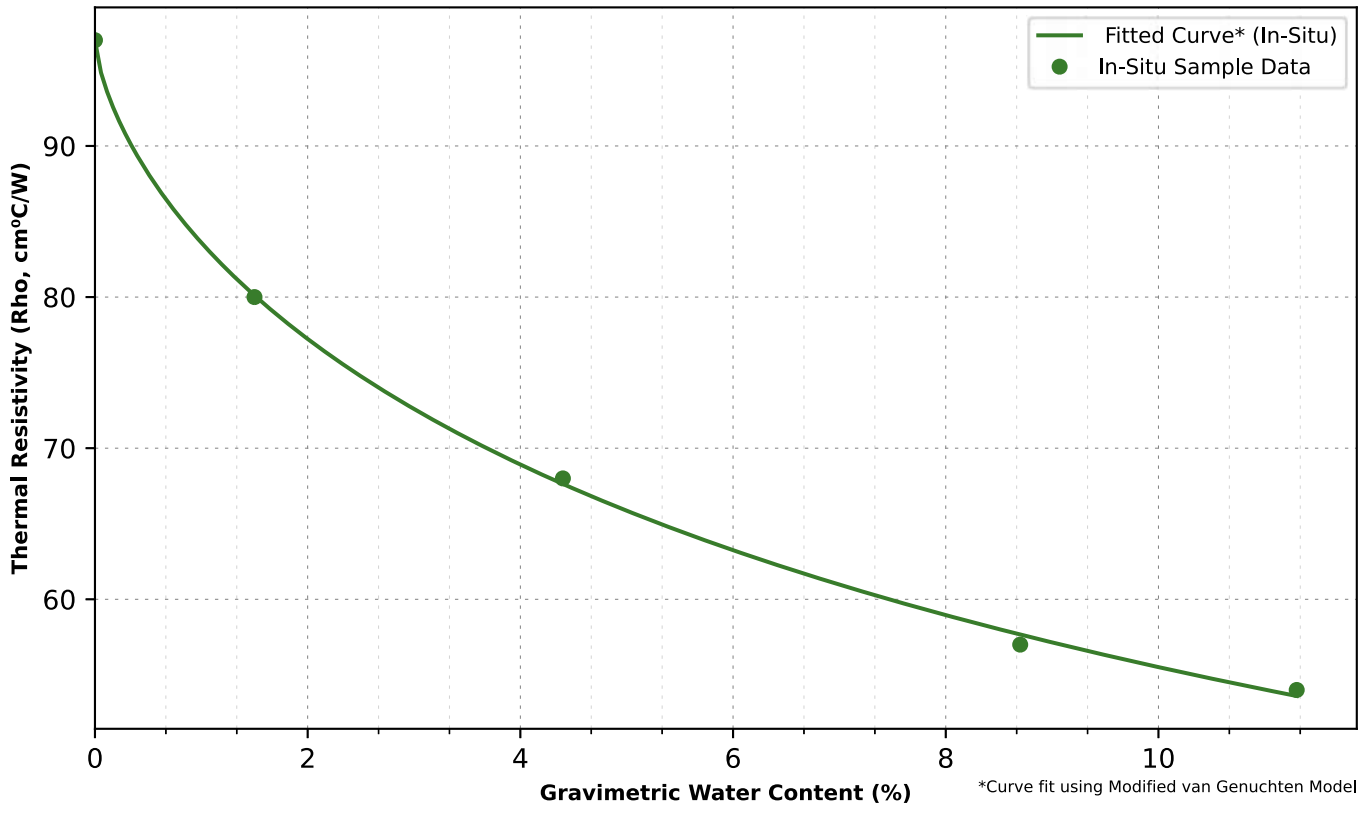
Location : B-219, 4'-8'
Soil Description : Lean Clay
USCS Soil Classification : CL

Summary of Test Results

TEMPOS Meter : Tempos : TEM00001839
Needle Used : TR-4: 4437
Needle Diameter/Length : 1.9mm/100mm
Method of Insertion : Pushed
Grease Used : Arctic MX-4

In-Situ Sample		
WC (%)	Thermal Resistivity (cm°C/W)	Test Temp (°C)
11.3	54	21.0
8.7	57	21.1
4.4	68	20.6
1.5	80	20.3
0.0	97	20.6

Thermal Characteristic Drying Curve



Application Version v02.17 | Produced by: Kyle Lemcke | SME by: Matthew Ridgway | Sample1_CompactionA

Subsurface Profile Fences

Phase 1 Fence Lines

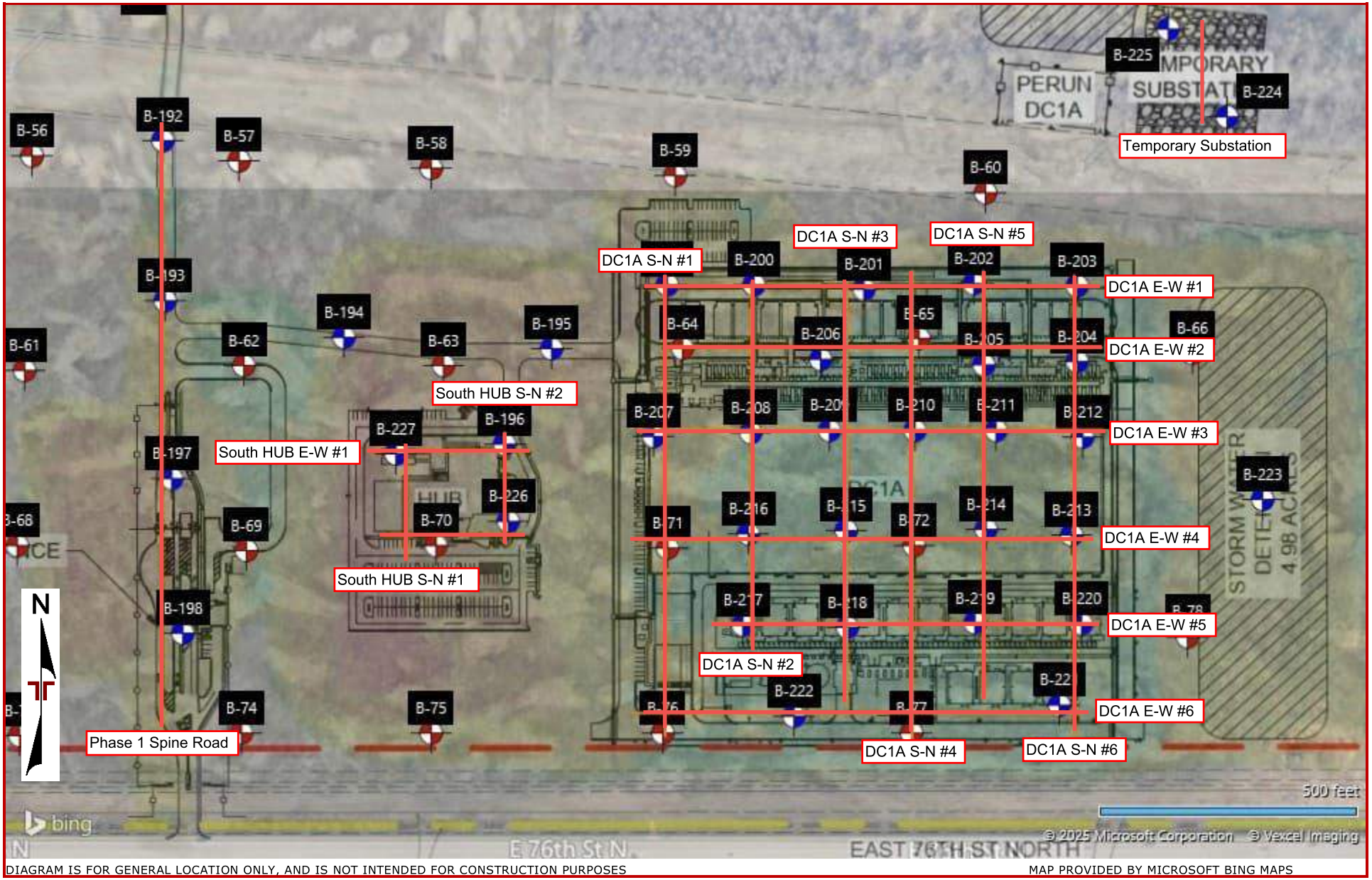


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

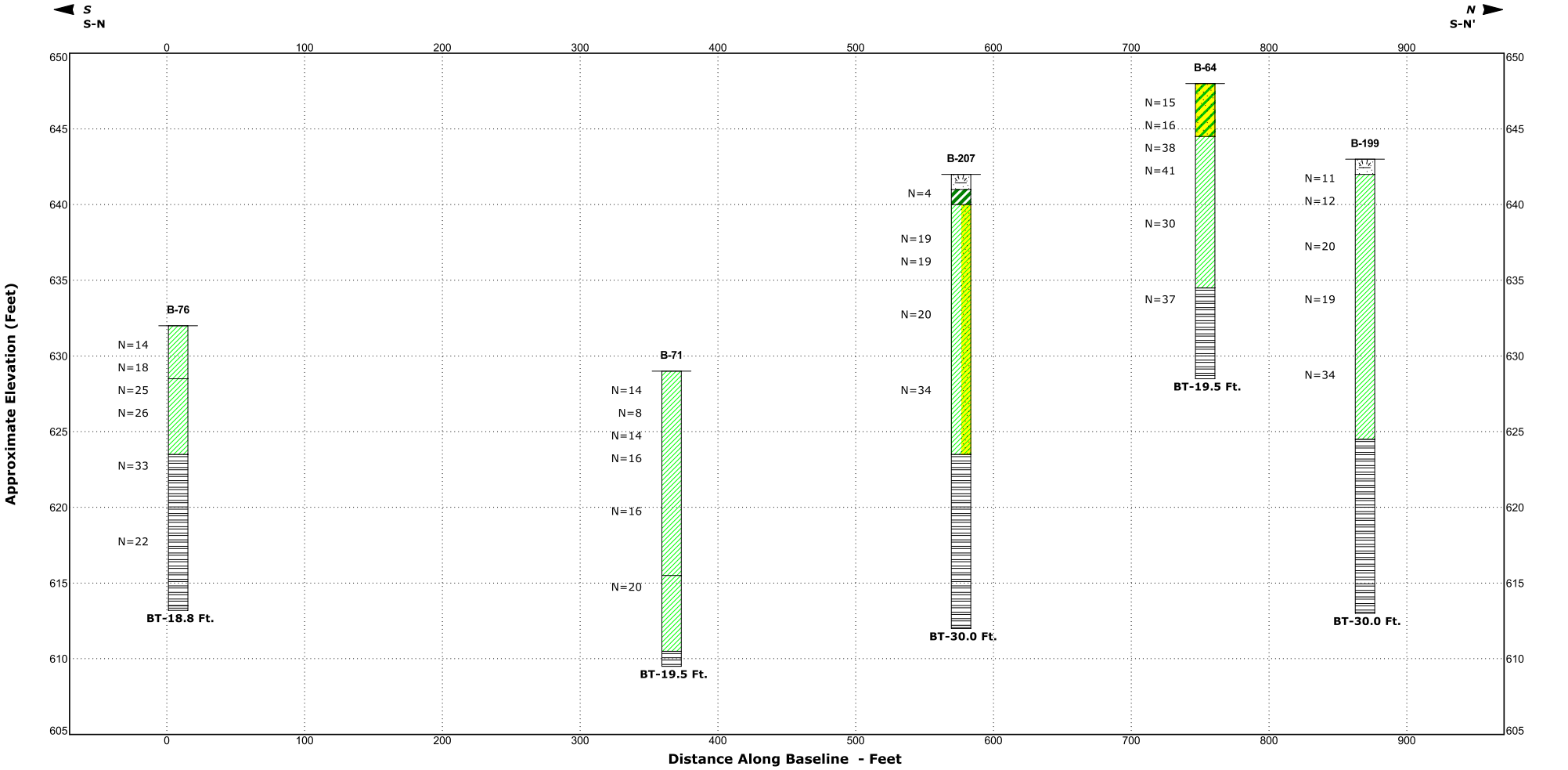
MAP PROVIDED BY MICROSOFT BING MAPS

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC1A S-N #1

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



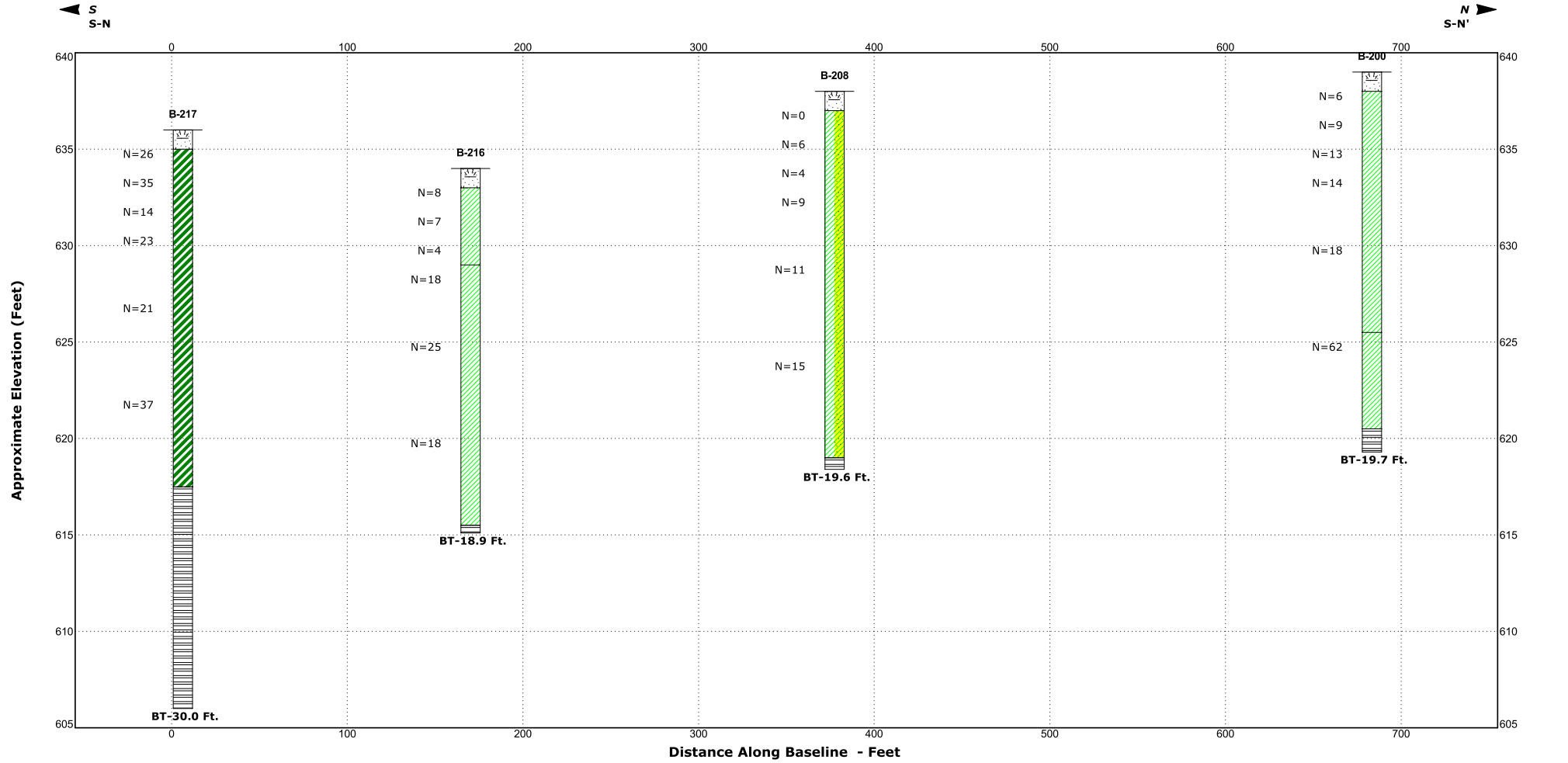
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-199 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay; Shale; Fat Clay; Lean Clay with Sand; Clayey Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC1A S-N #2

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



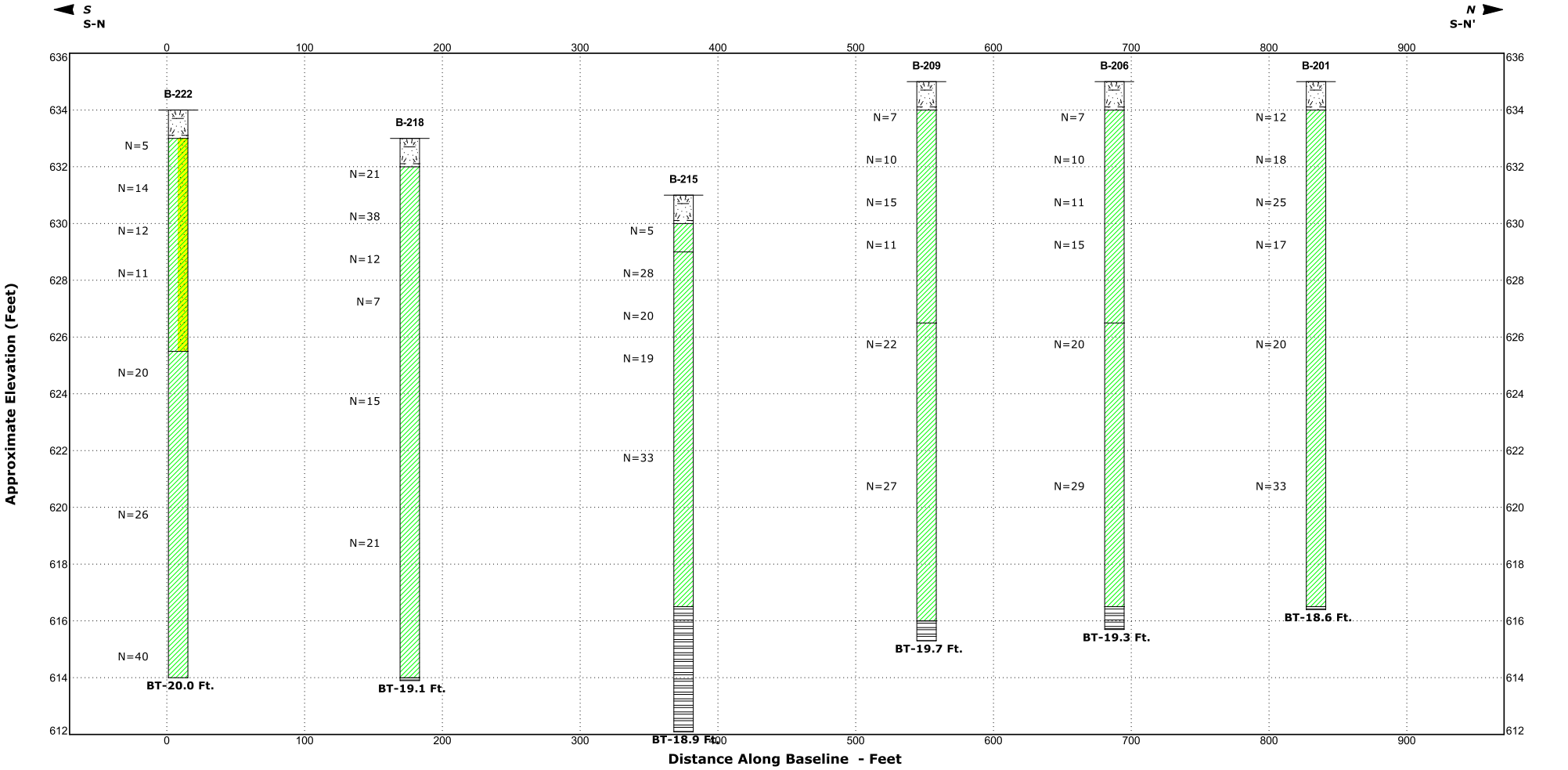
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-200 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR BT — Borehole Termination Type	Topsoil; Lean Clay; Shale; Lean Clay with Sand; Fat Clay

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC1A S-N #3

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



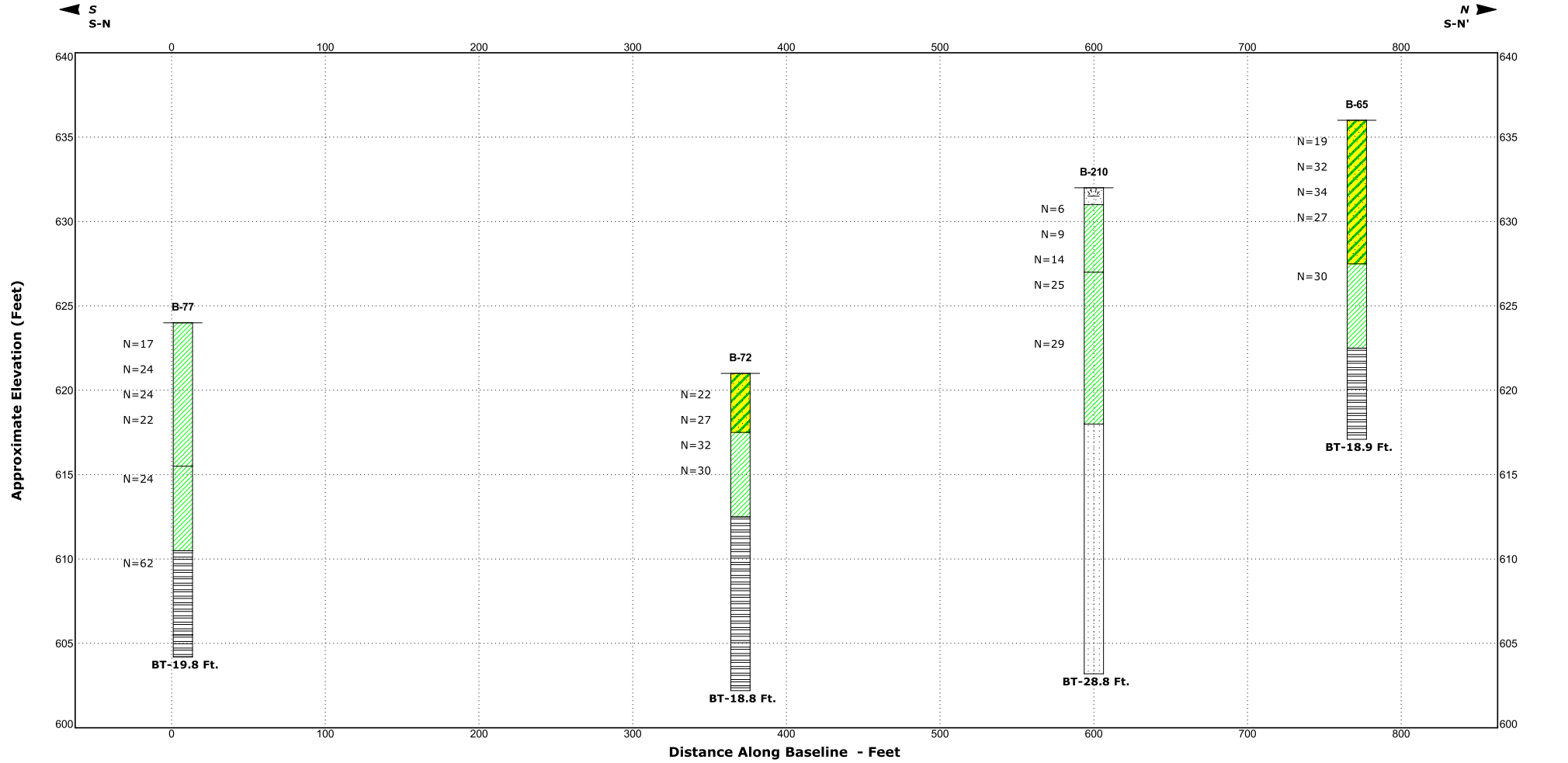
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-201 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil Lean Clay Shale Lean Clay with Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC1A S-N #4

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



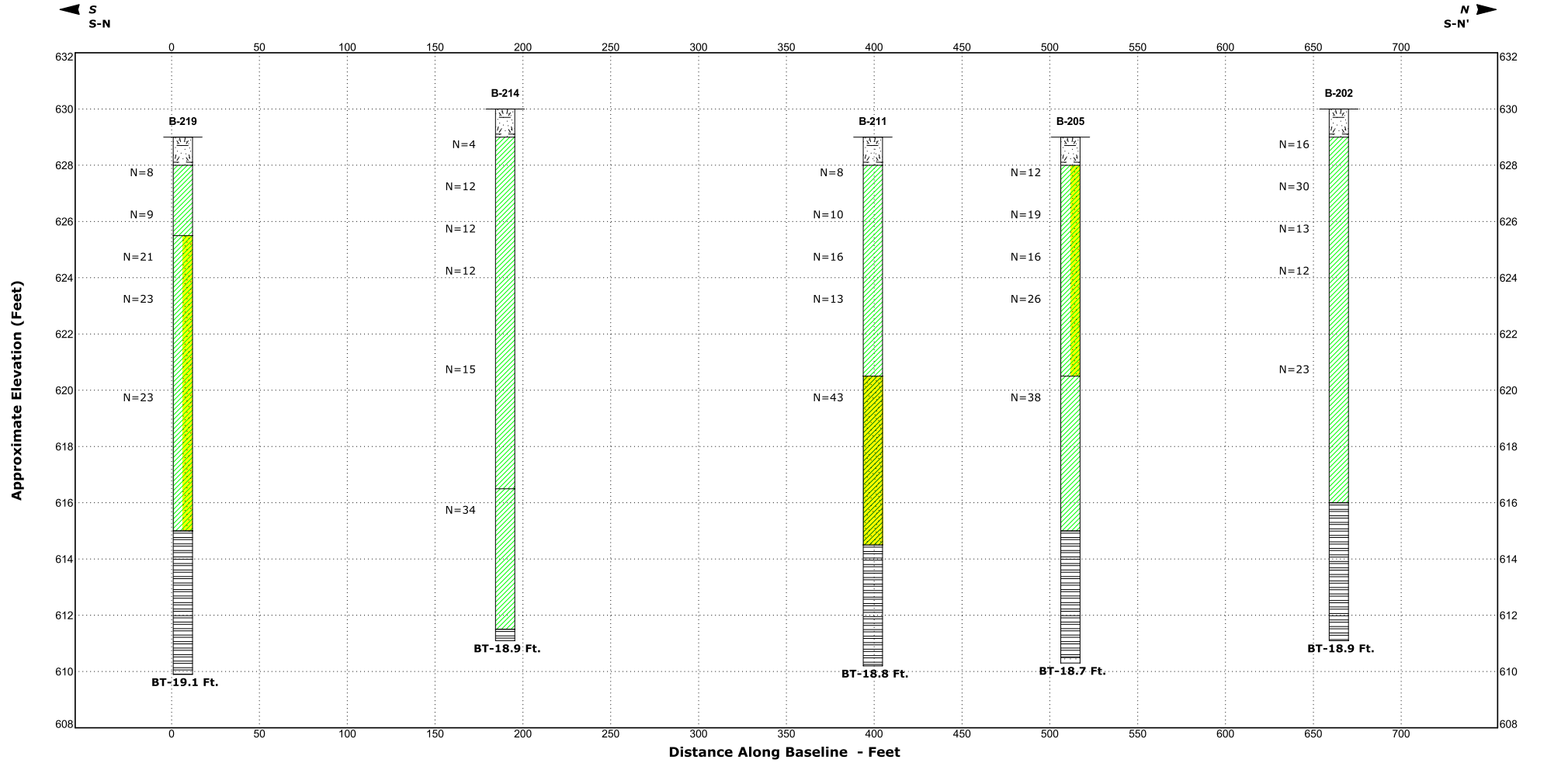
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-210 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil, Lean Clay, Sandstone, Clayey Sand, Shale

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC1A S-N #5

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



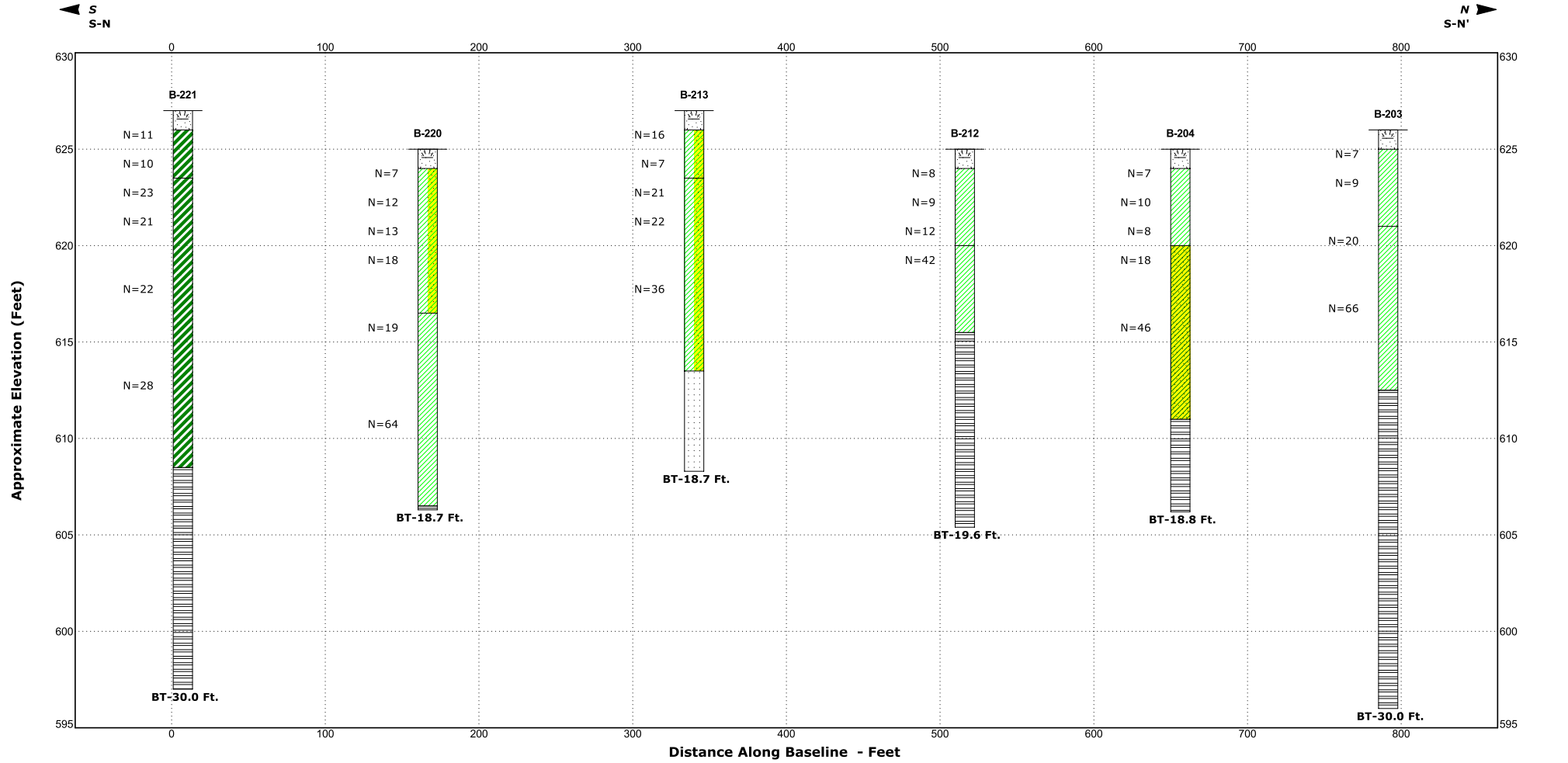
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-202 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR BT — Borehole Termination Type	Topsoil Lean Clay Shale Lean Clay with Sand Sandstone Sandy Lean Clay

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC1A S-N #6

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



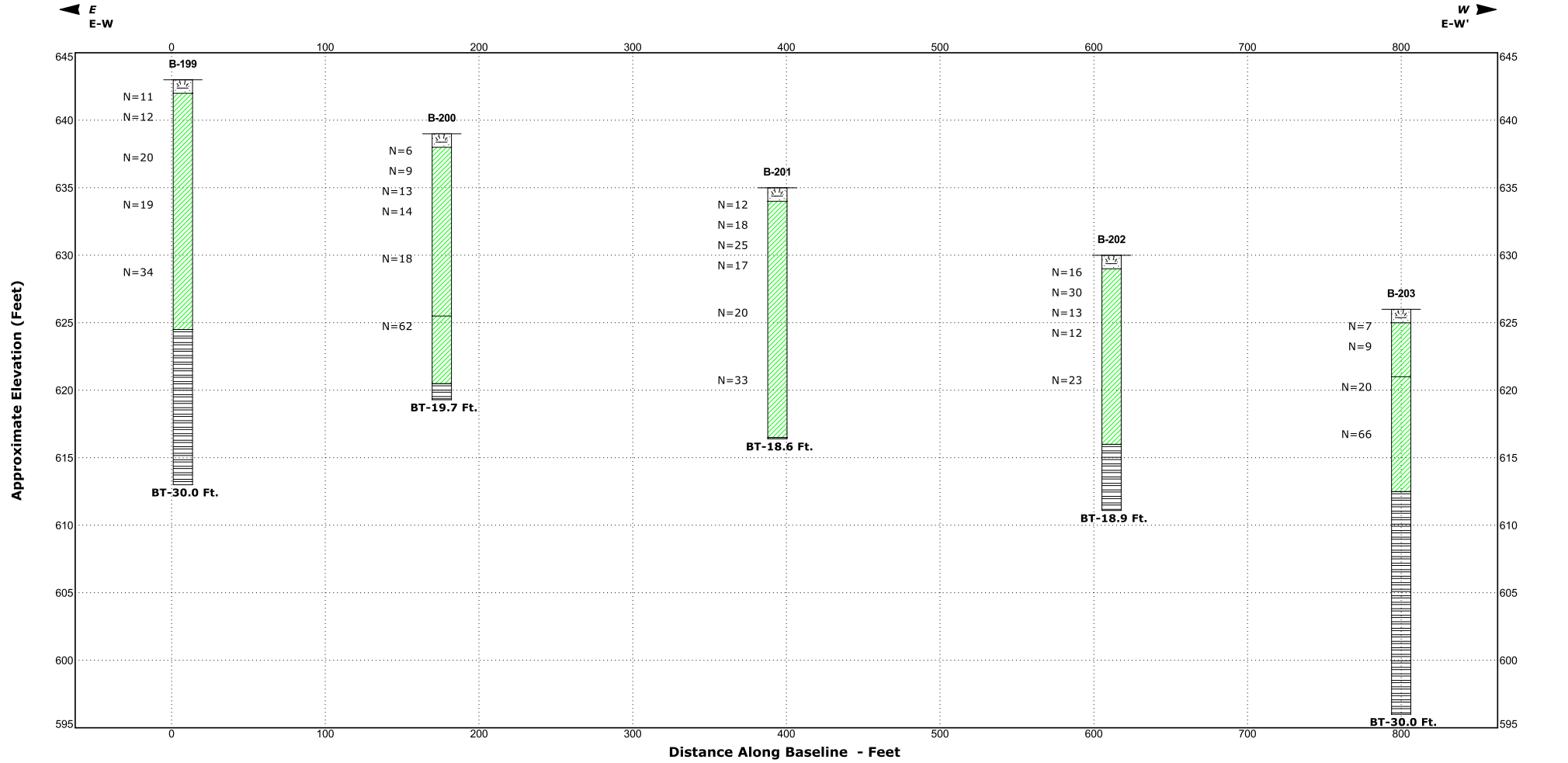
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-203 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR BT — Borehole Termination Type	Topsoil, Lean Clay, Shale, Sandy Lean Clay, Lean Clay with Sand, Sandstone, Fat Clay

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC1A E-W #1

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



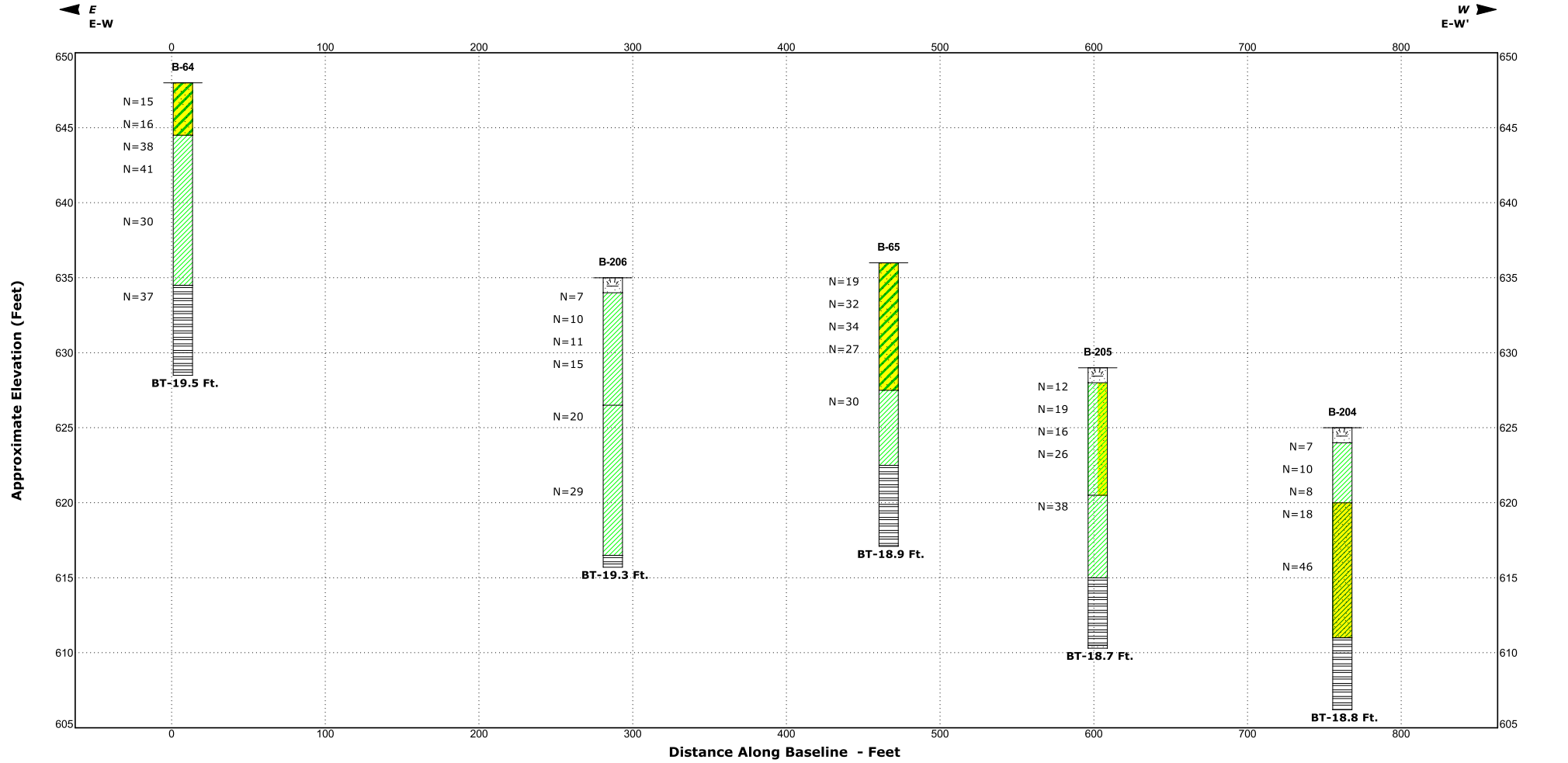
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-199 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil Lean Clay Shale

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC1A E-W #2

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



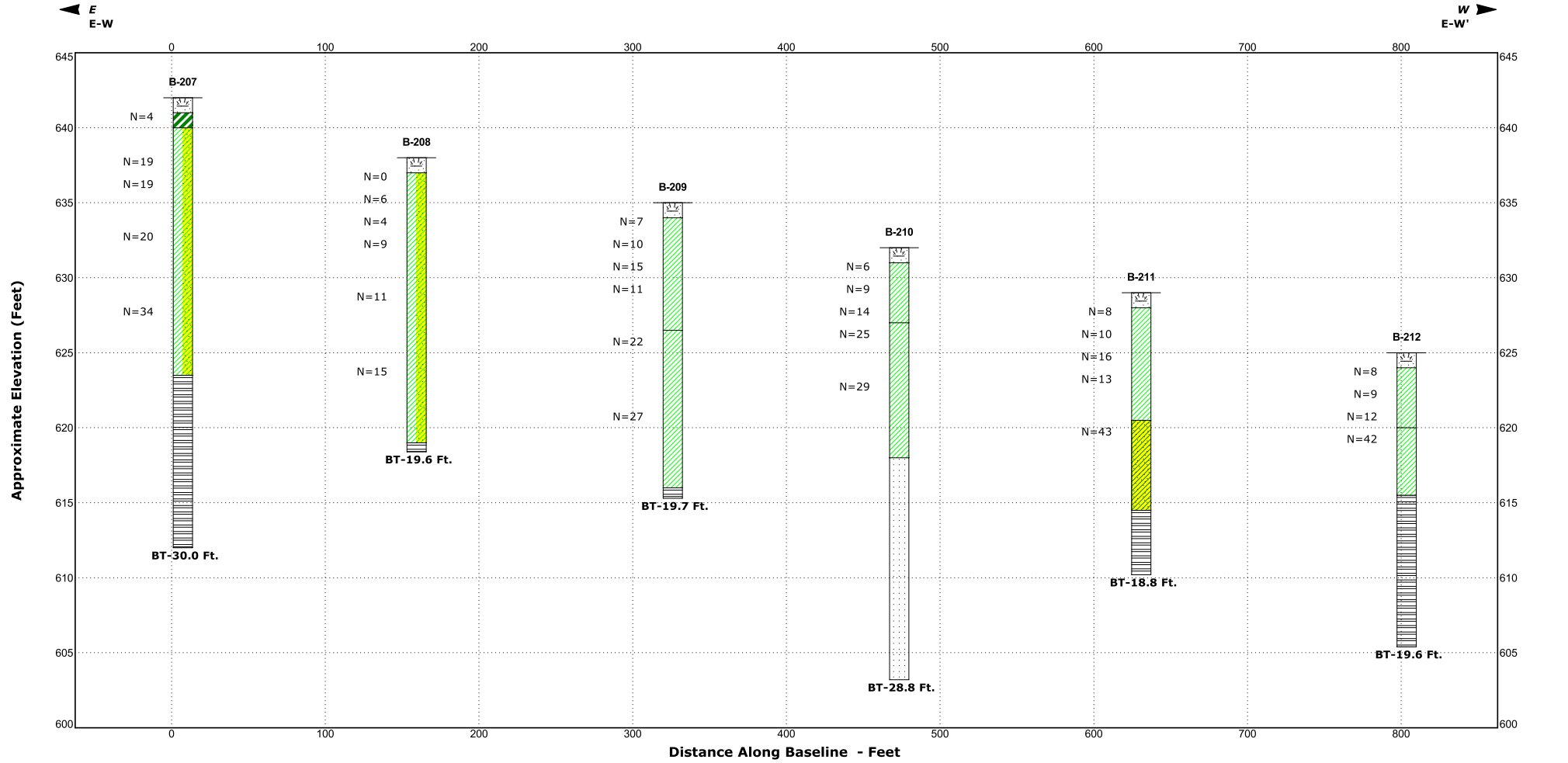
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-204 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR BT — Borehole Termination Type	Topsoil; Lean Clay; Sandy Lean Clay; Shale; Lean Clay with Sand; Sandstone; Clayey Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC1A E-W #3

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



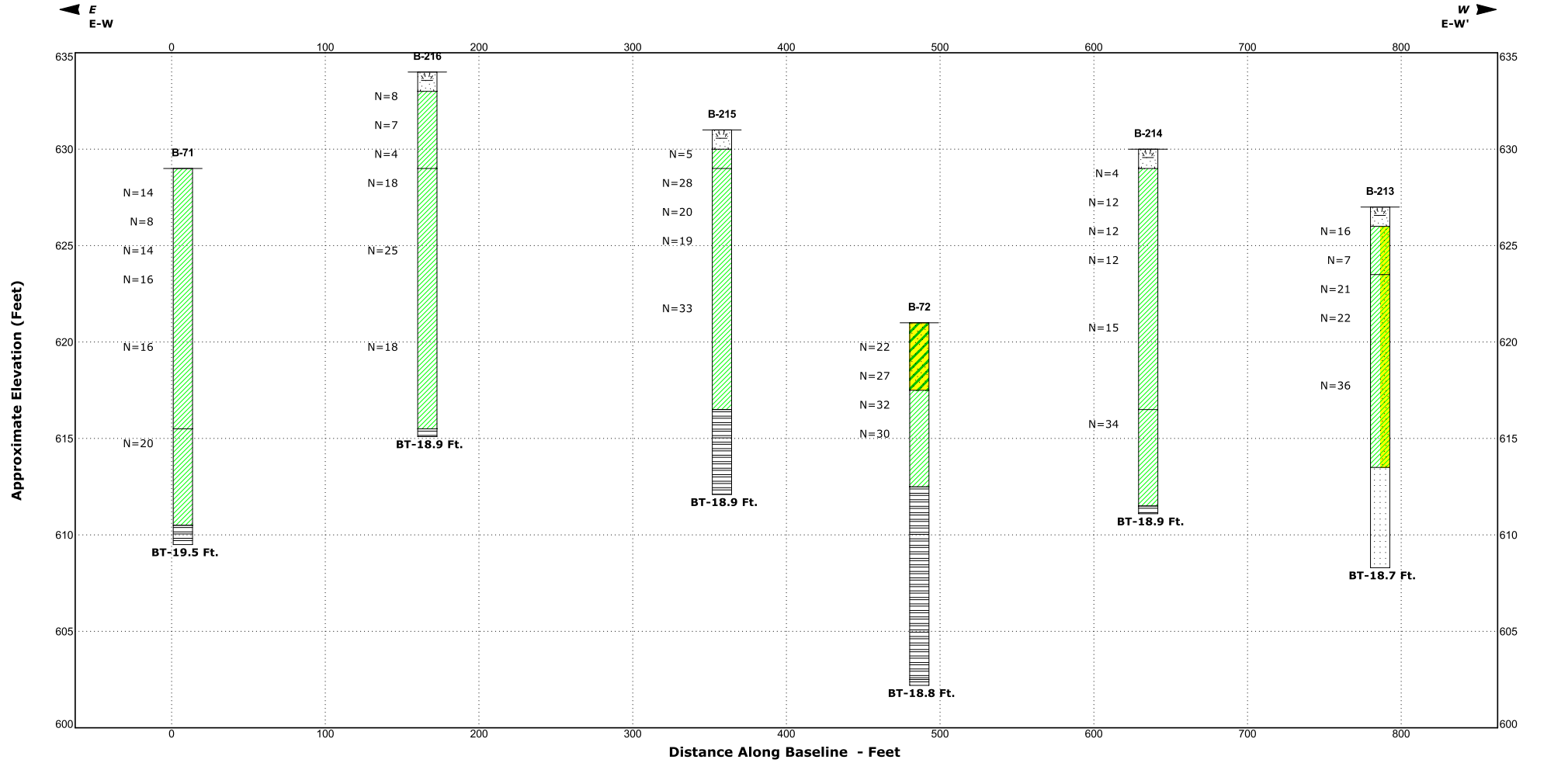
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-207 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Fat Clay; Lean Clay with Sand; Shale; Lean Clay; Sandstone; Sandy Lean Clay

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC1A E-W #4

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



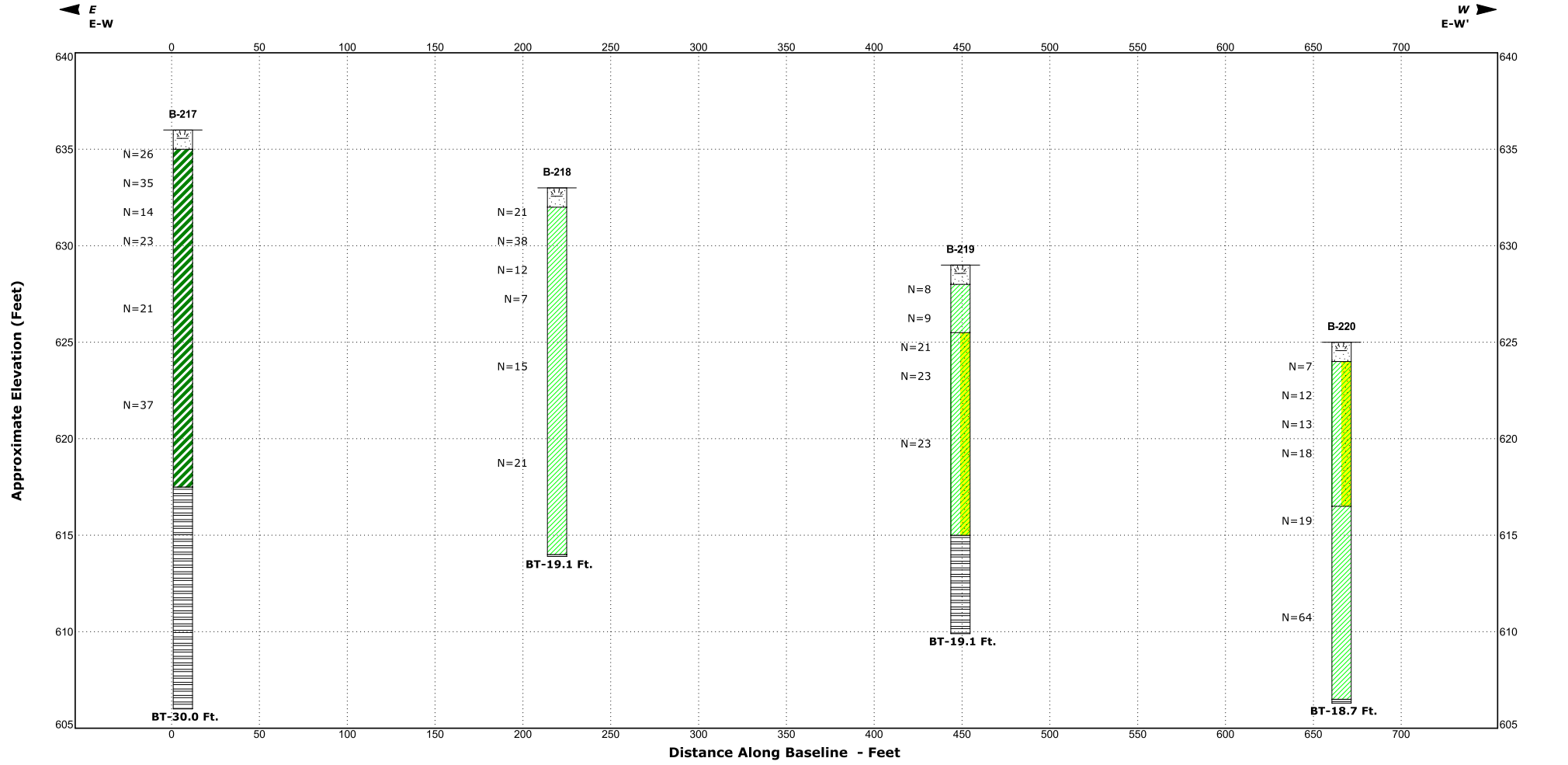
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-213 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR BT — Borehole Termination Type	Topsoil Lean Clay with Sand Sandstone Lean Clay Shale Clayey Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC1A E-W #5

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



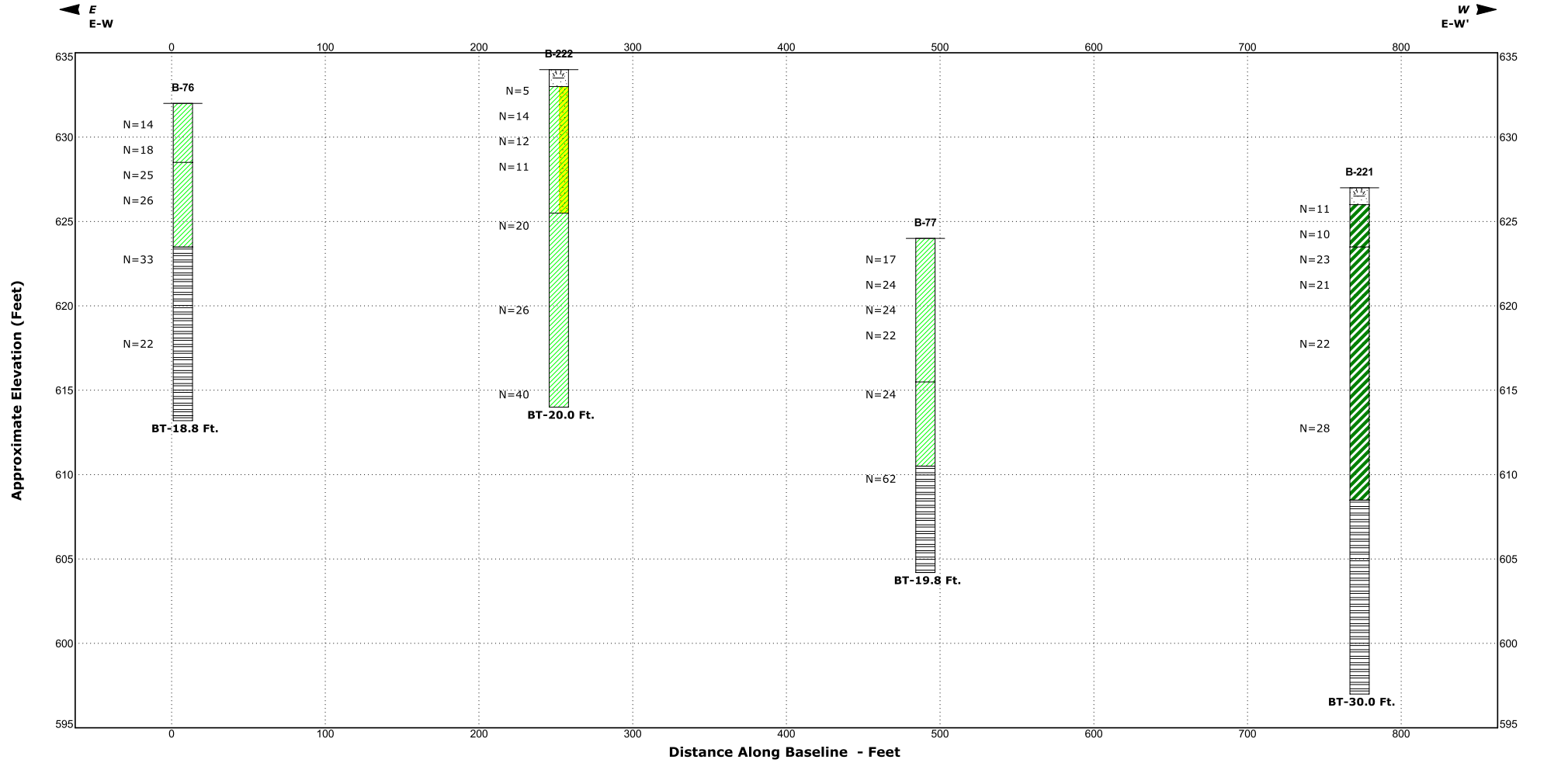
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-217 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Fat Clay; Shale; Lean Clay; Lean Clay with Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC1A E-W #6

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



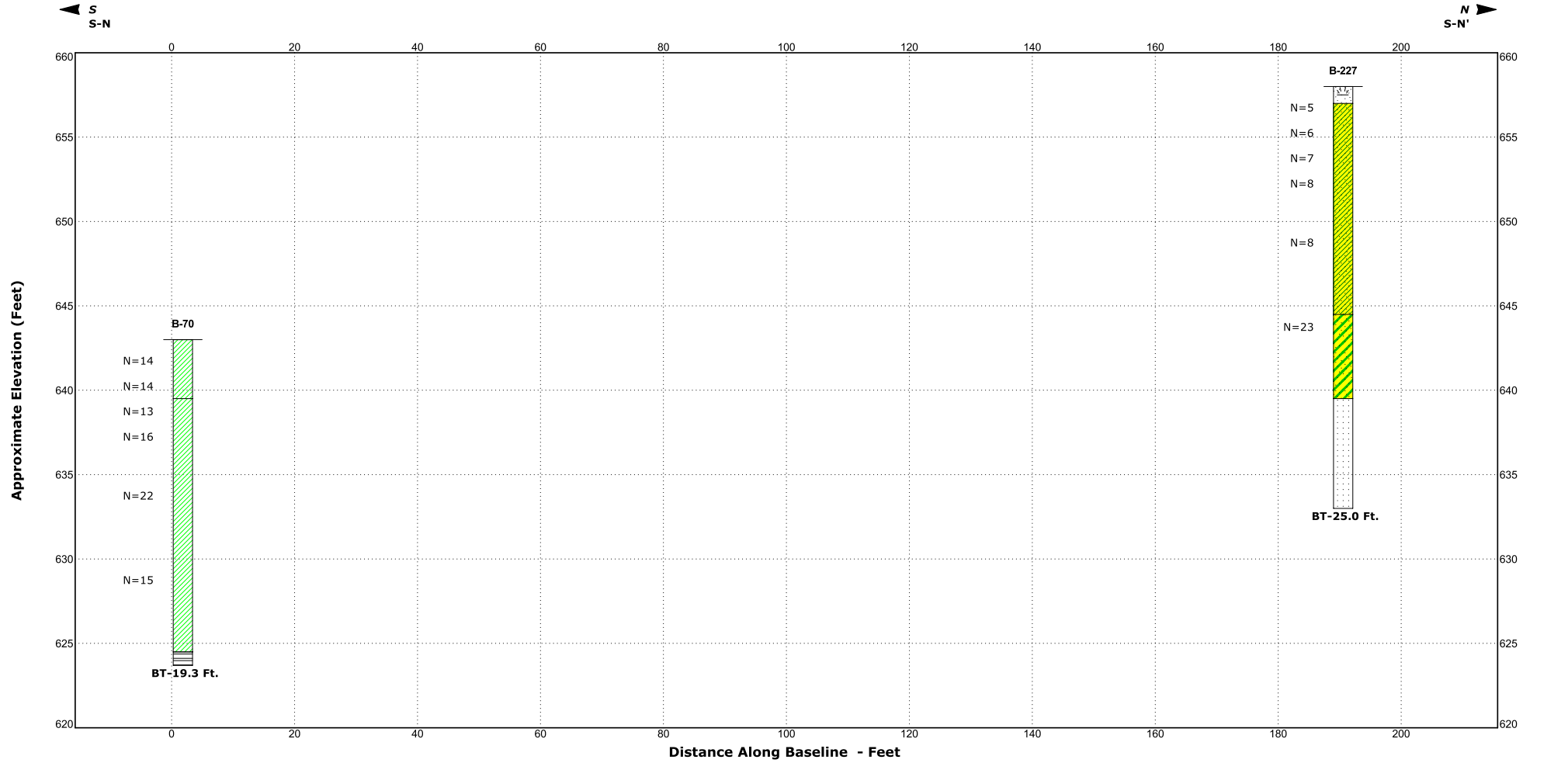
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-221 — Borehole Number Moisture Content — %w; LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Fat Clay; Shale; Lean Clay with Sand; Lean Clay

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

South HUB S-N #1

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



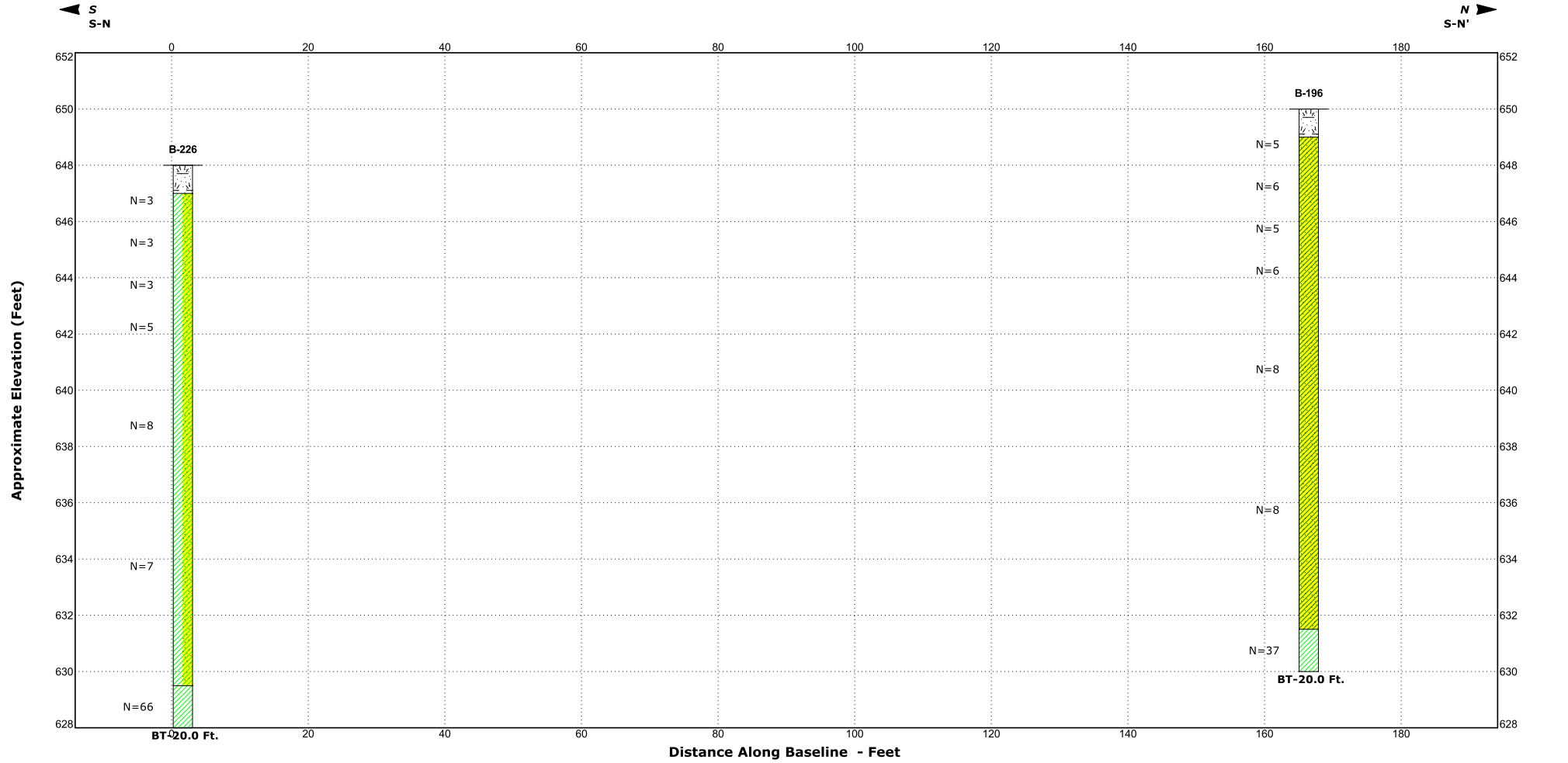
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-227 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Sandy Lean Clay; Clayey Sand; Sandstone; Lean Clay; Shale

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

South HUB S-N #2

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



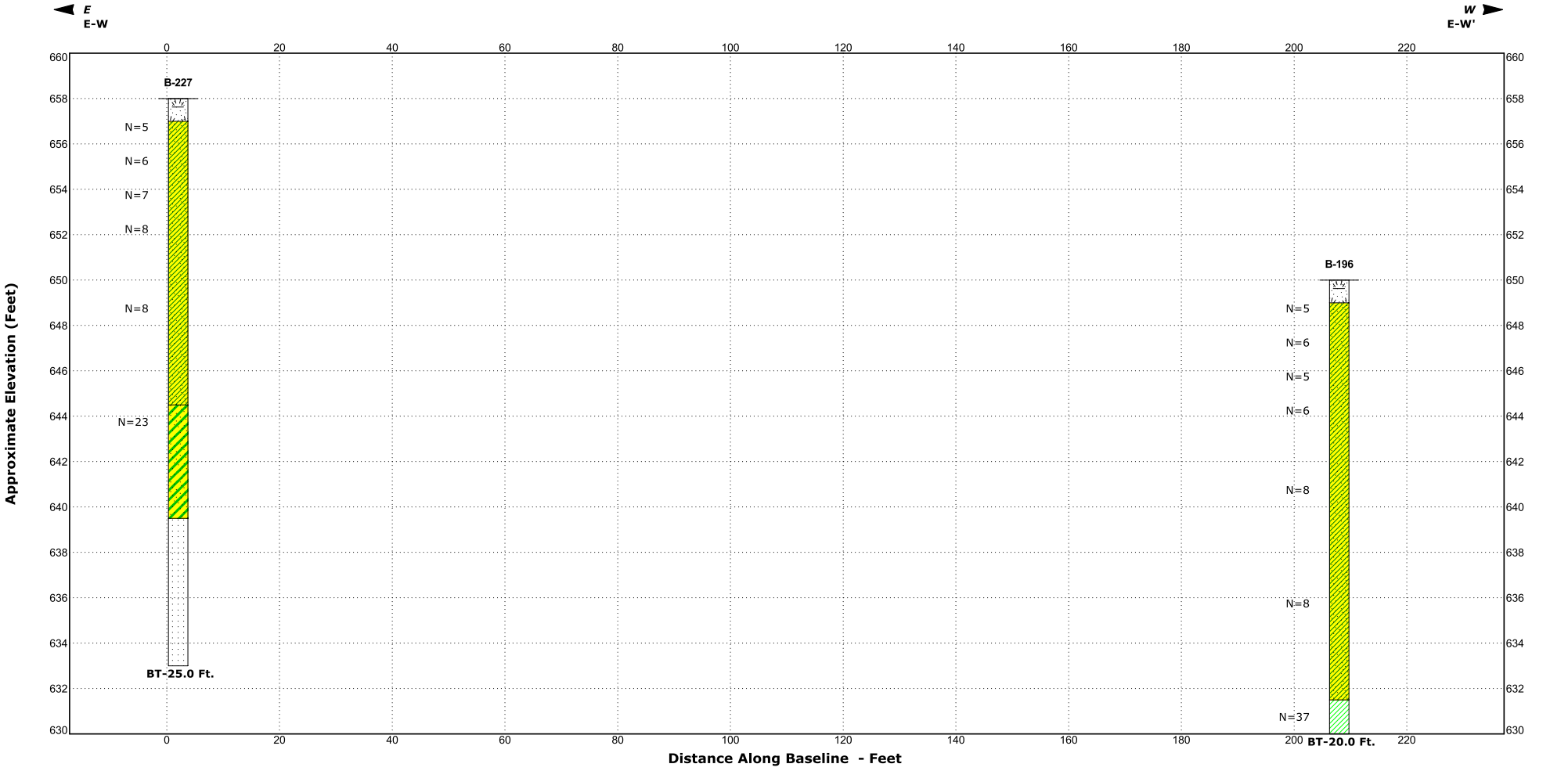
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-196 — Borehole Number Moisture Content — %w; LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Sandy Lean Clay; Lean Clay; Lean Clay with Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

South HUB E-W #1

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



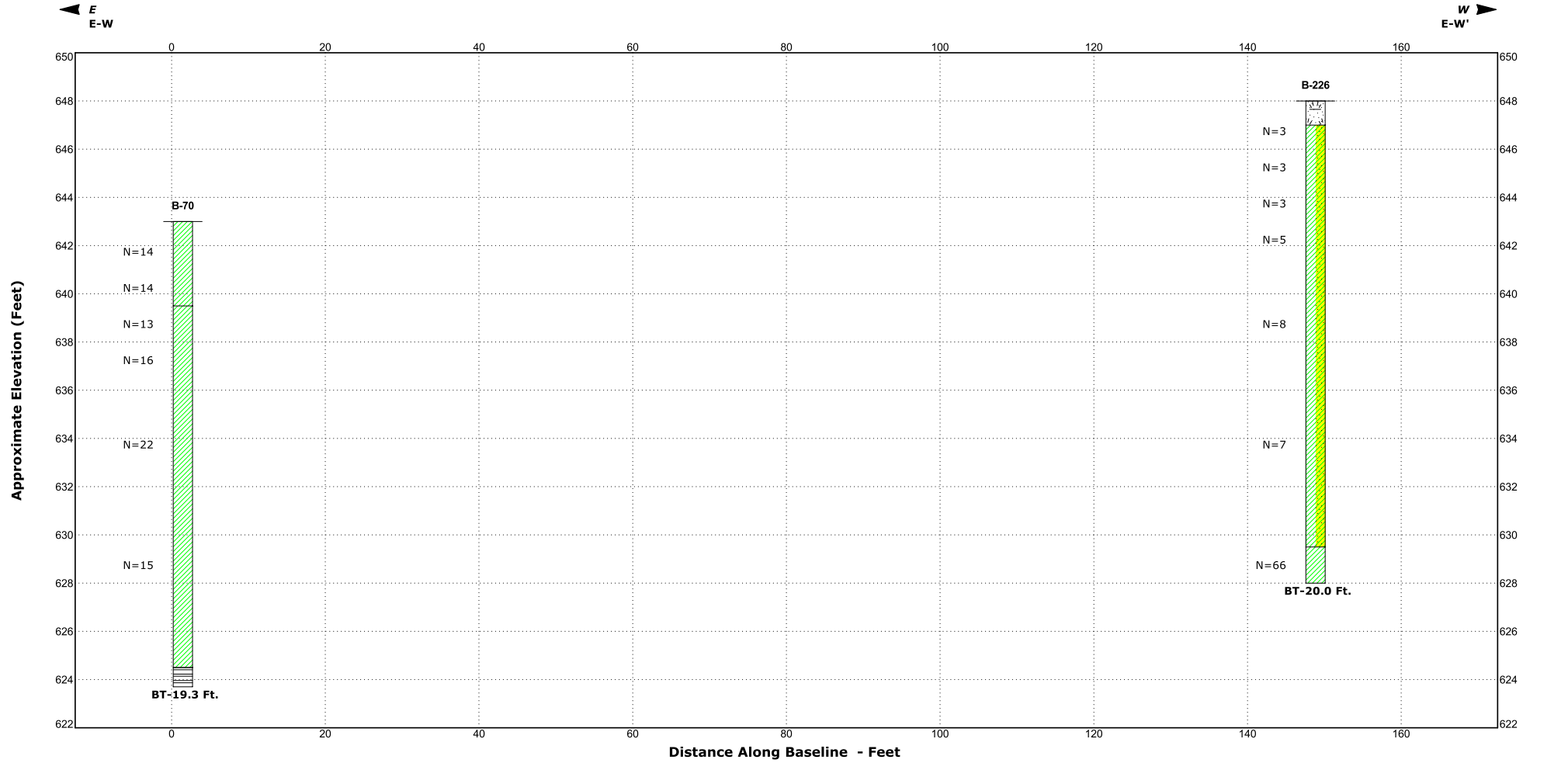
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-196 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Sandy Lean Clay; Lean Clay; Clayey Sand; Sandstone

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

South HUB E-W #2

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



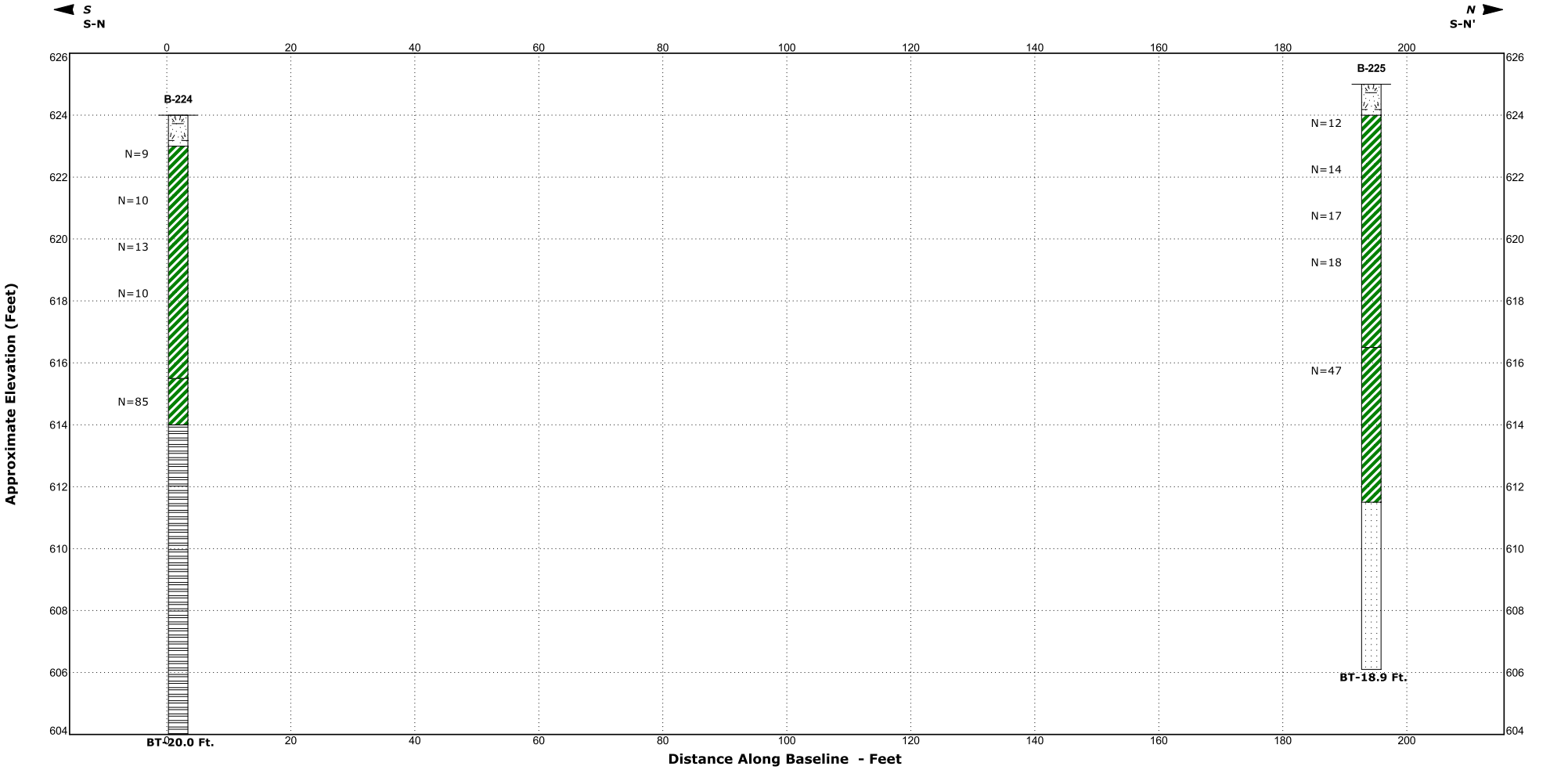
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-226 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay with Sand; Lean Clay; Shale

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

Temporary Substation

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



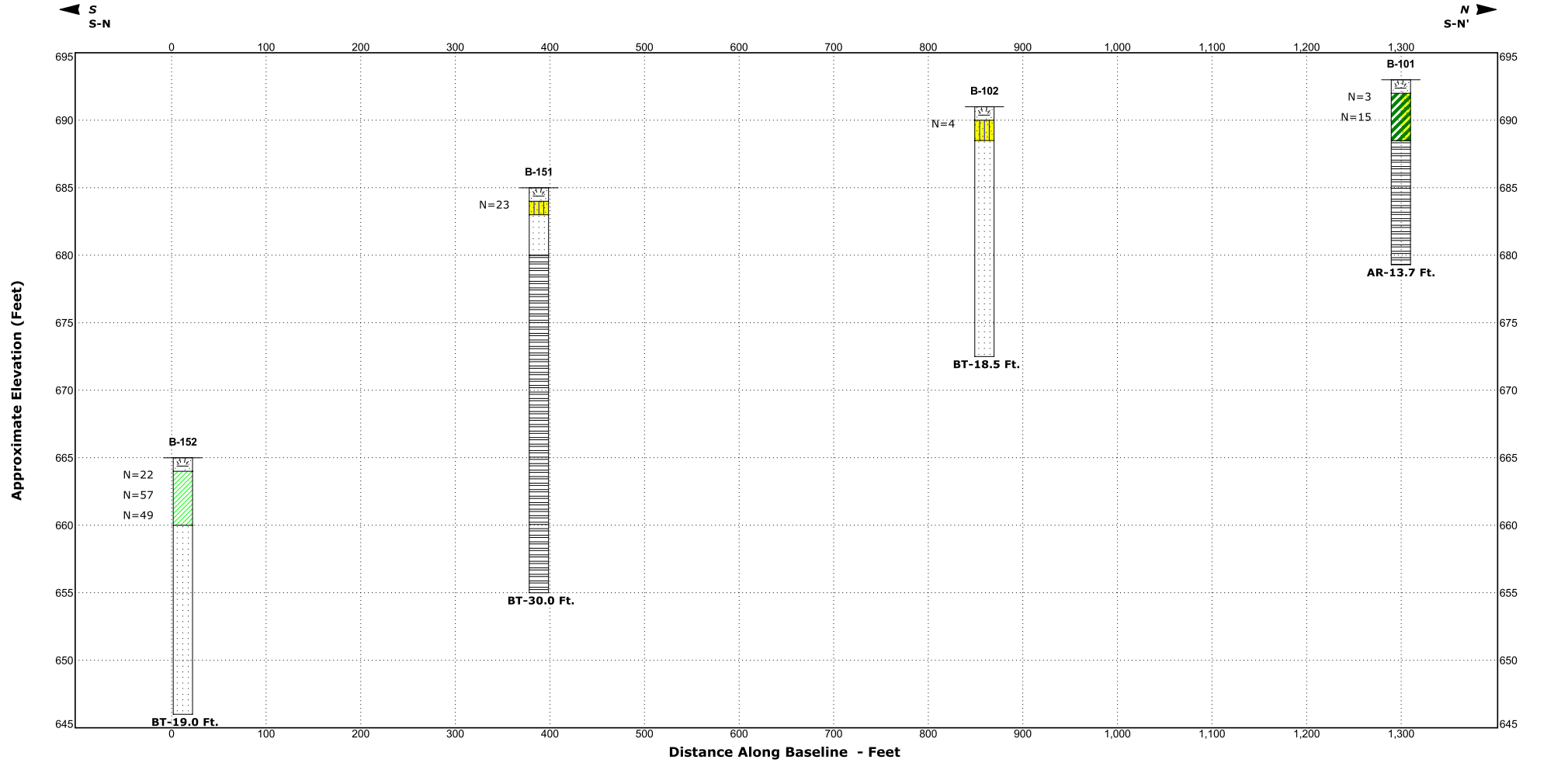
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-224 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR BT — Borehole Termination Type	Topsoil, Fat Clay, Shale, Sandstone

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

Phase 3 Spine Road

9522 E 47th Pl, Ste D
Tulsa, OK



Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-101 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Fat Clay with Sand; Shale; Silty Sand; Sandstone; Lean Clay

Phase 2 Fence Lines

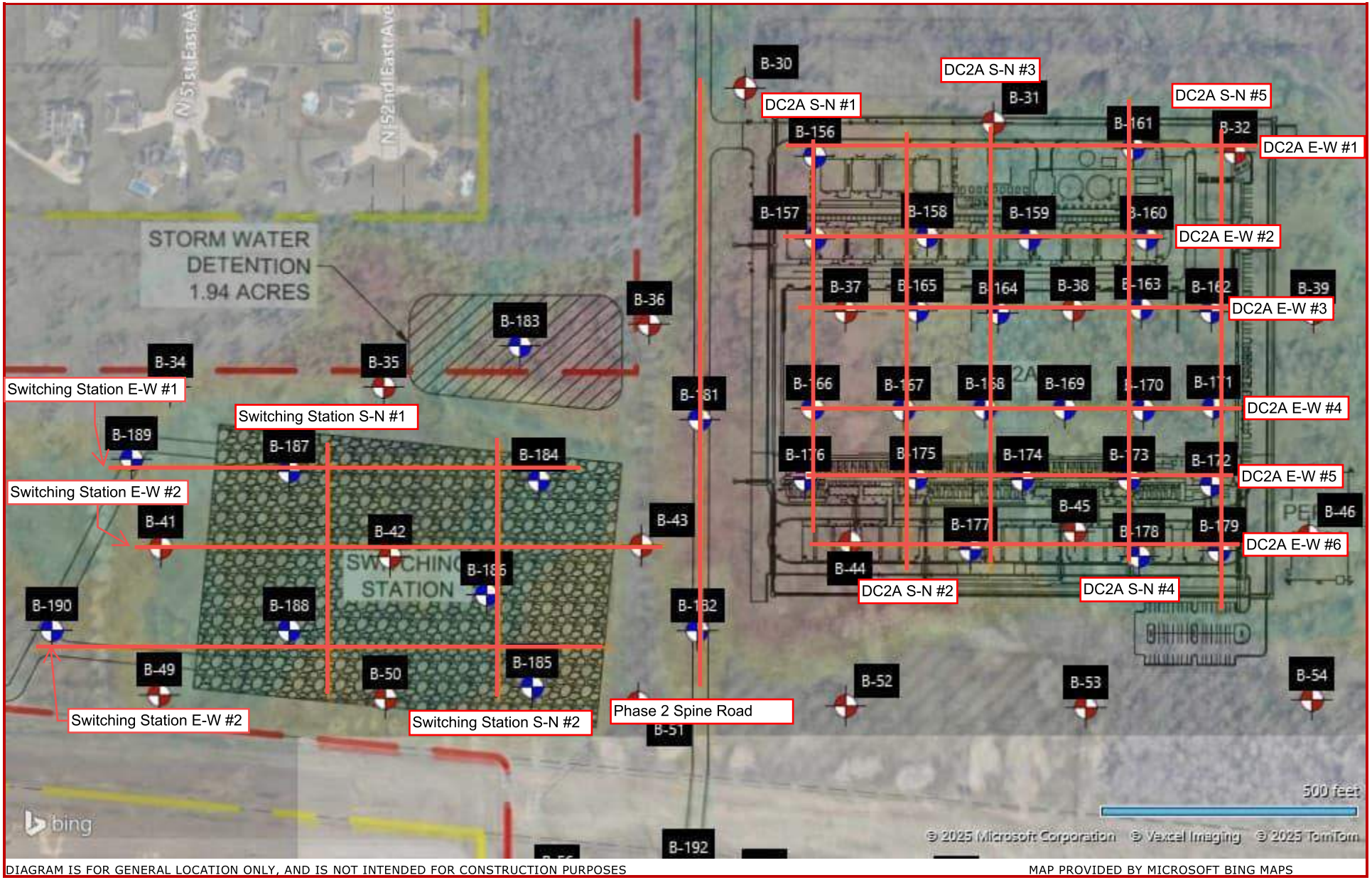


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

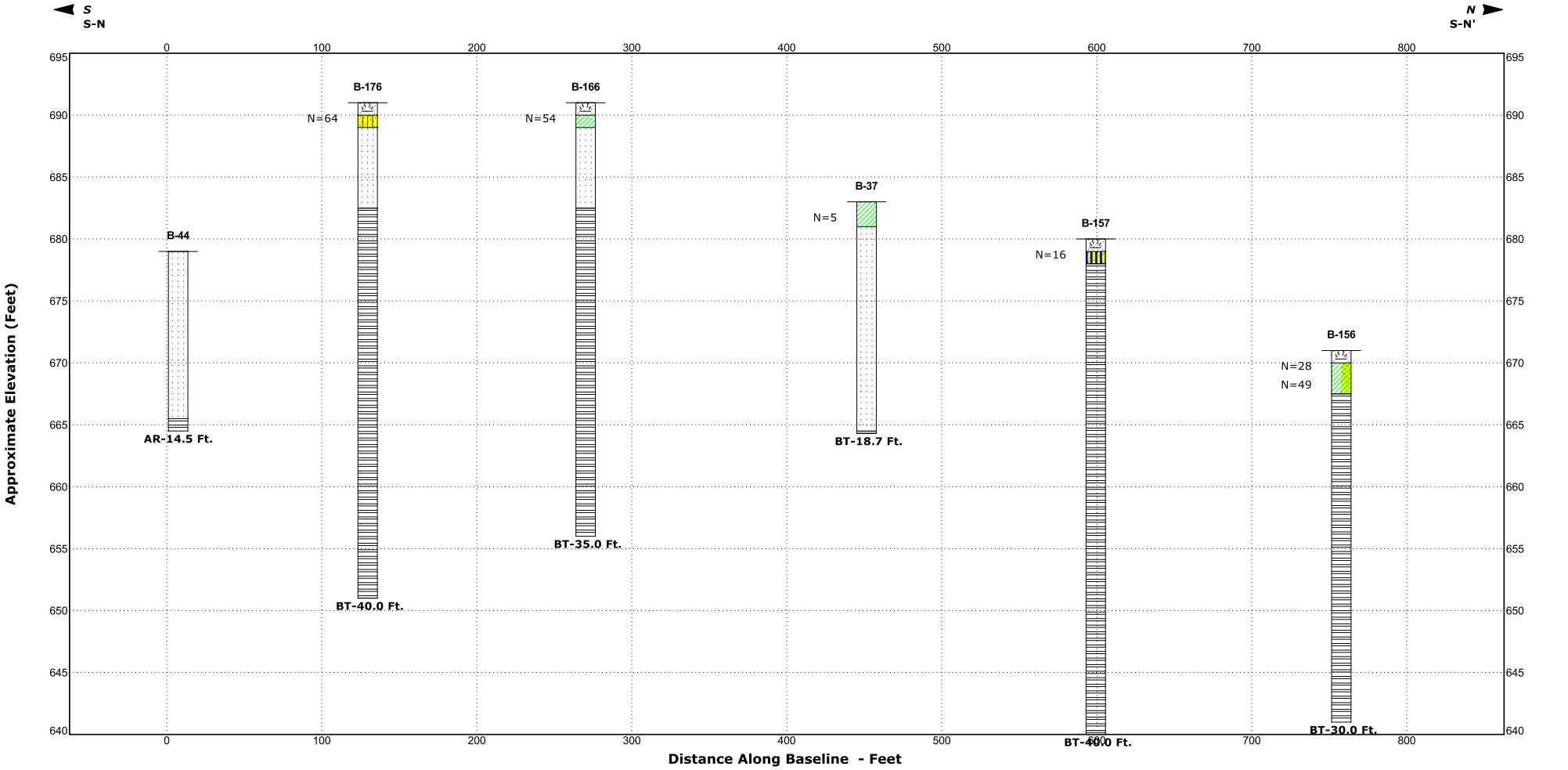
MAP PROVIDED BY MICROSOFT BING MAPS

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC2A S-N #1

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



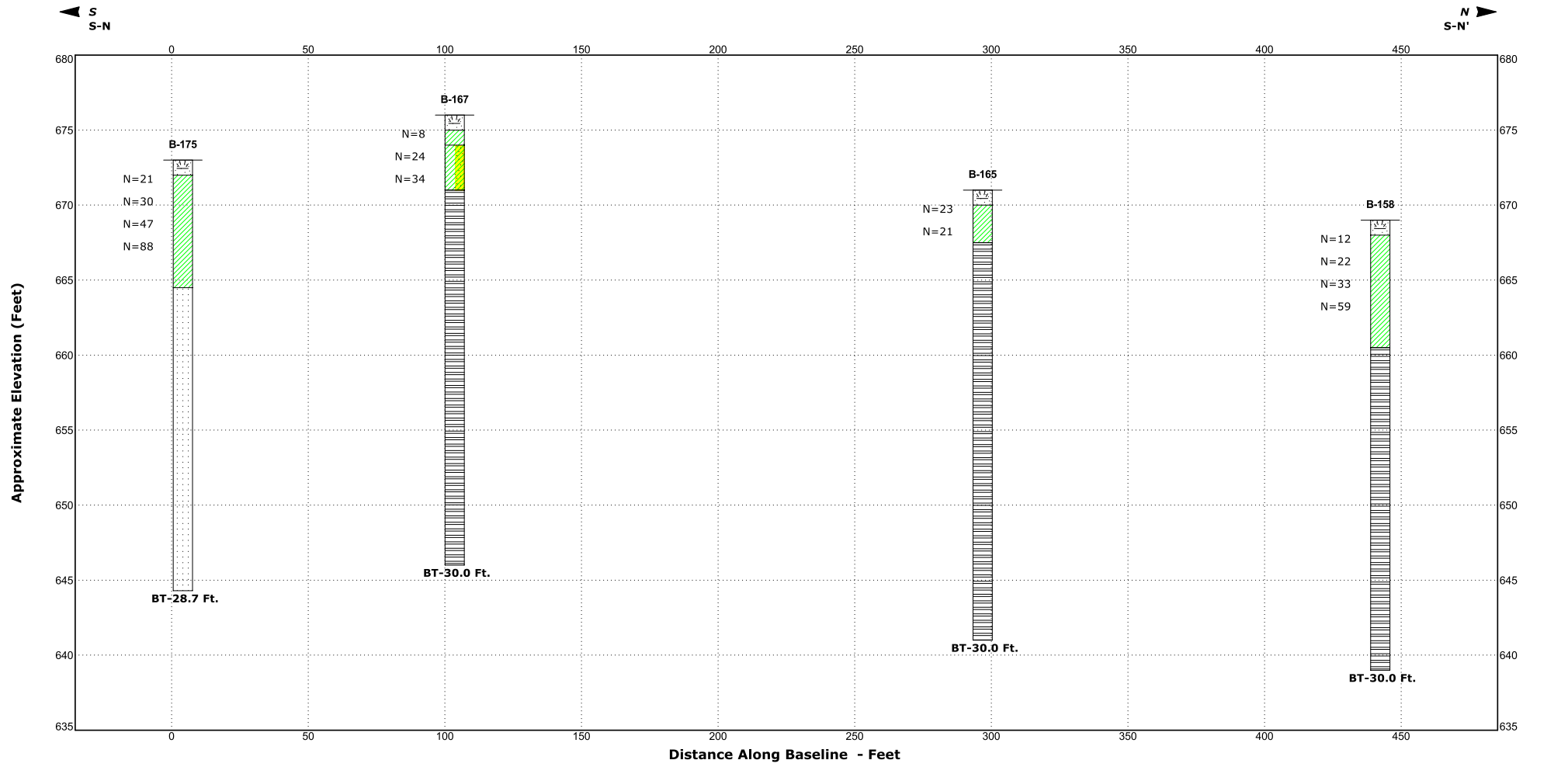
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-156 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay with Sand; Shale; Sandy Silt; Lean Clay; Sandstone; Silty Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC2A S-N #2

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



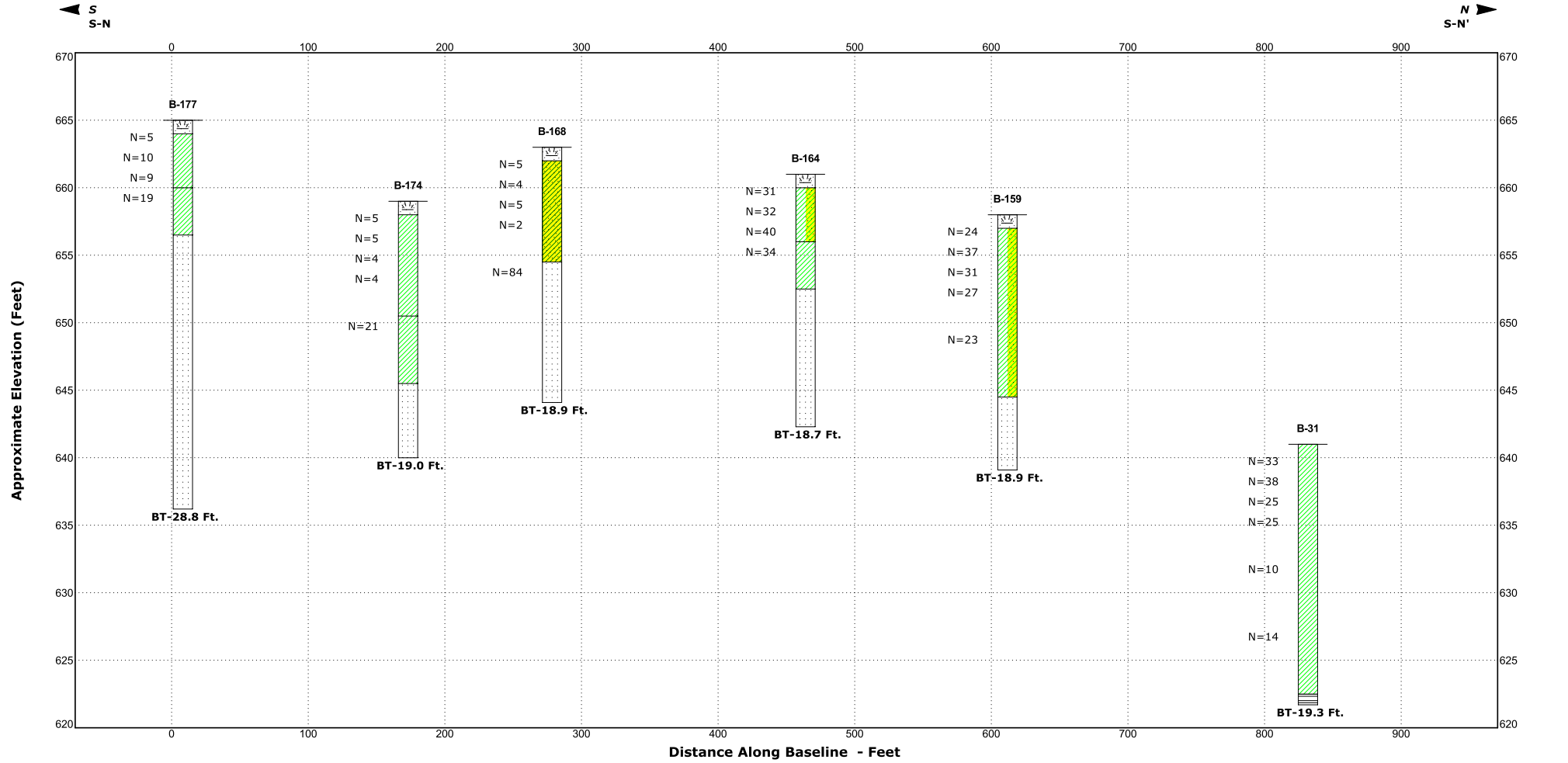
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-158 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR BT — Borehole Termination Type	Topsoil Lean Clay Shale Lean Clay with Sand Sandstone

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC2A S-N #3

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



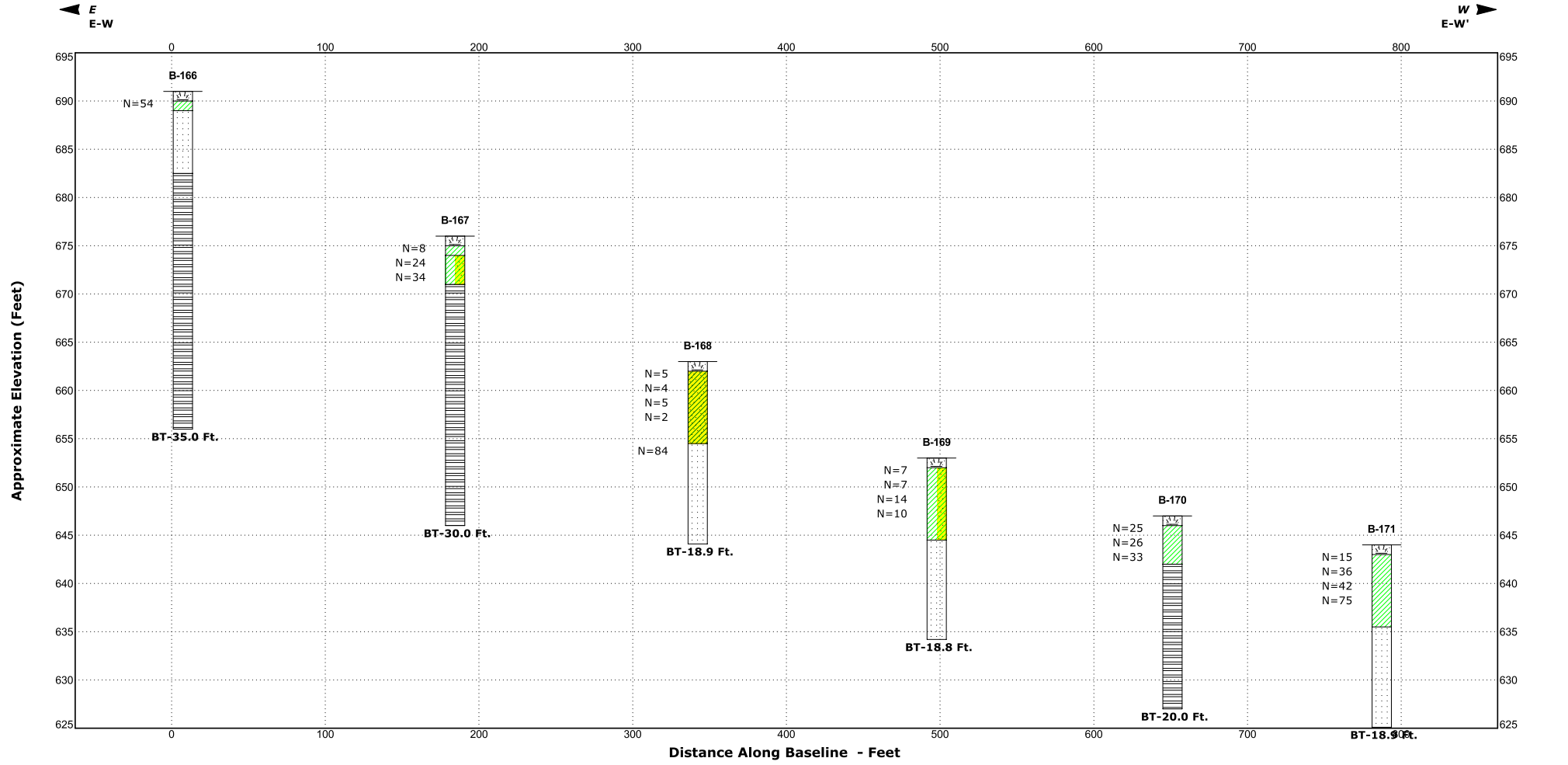
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-159 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay with Sand; Sandstone; Lean Clay; Sandy Lean Clay; Shale

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC2A E-W #4

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



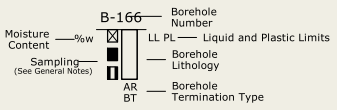
Notes

See Exploration Plan for orientation of soil profile.
See General Notes in Supporting Information for symbols and soil classifications.
Soils profile provided for illustration purposes only.
Soils between borings may differ
AR - Auger Refusal
BT - Boring Termination

Water Level Observations

Water Level Reading at time of drilling.
Water Level Reading after drilling.

Explanation



Material Legend

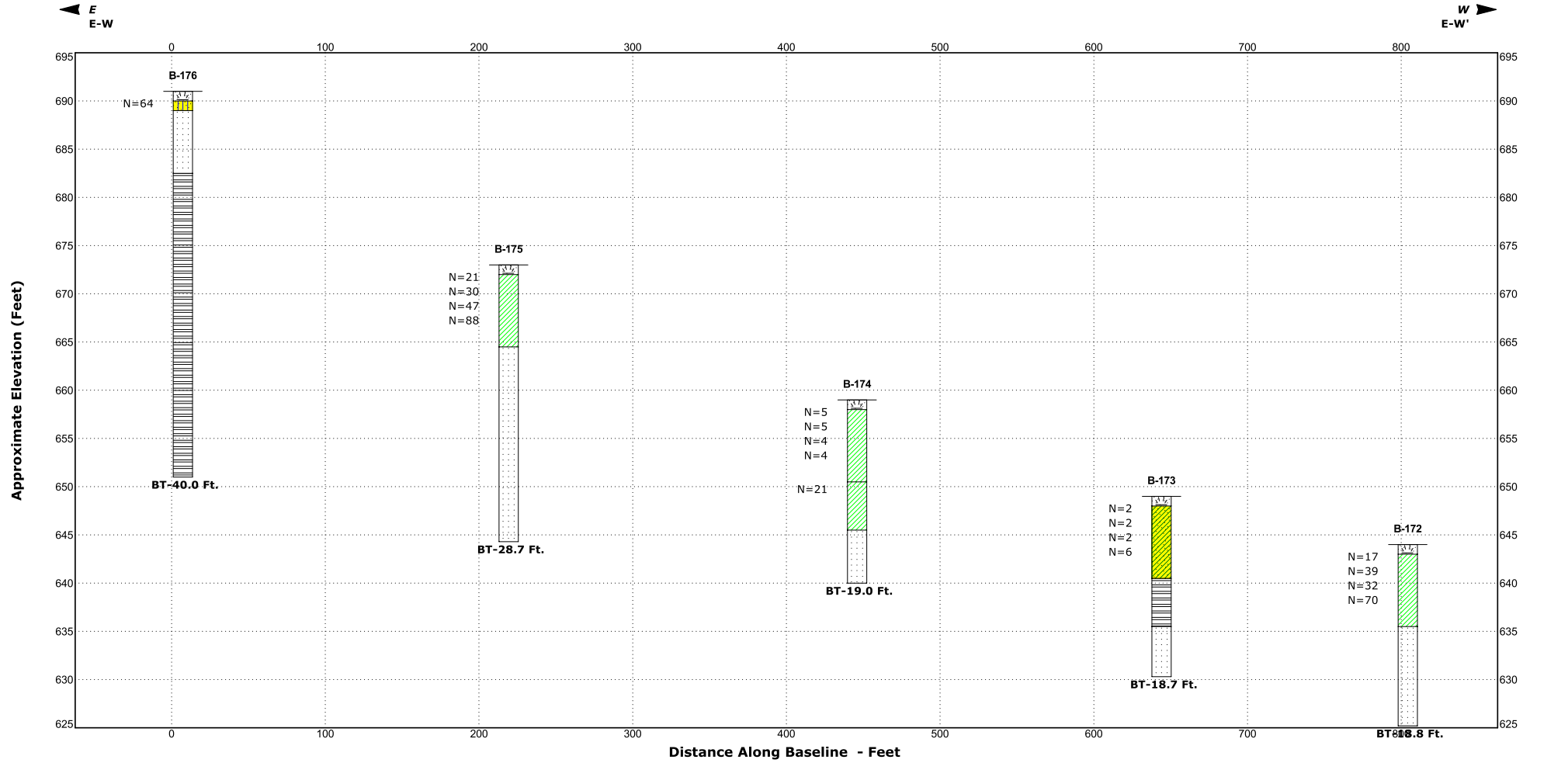
Topsoil
Lean Clay
Sandstone
Shale
Lean Clay with Sand
Sandy Lean Clay

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC2A E-W #5

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



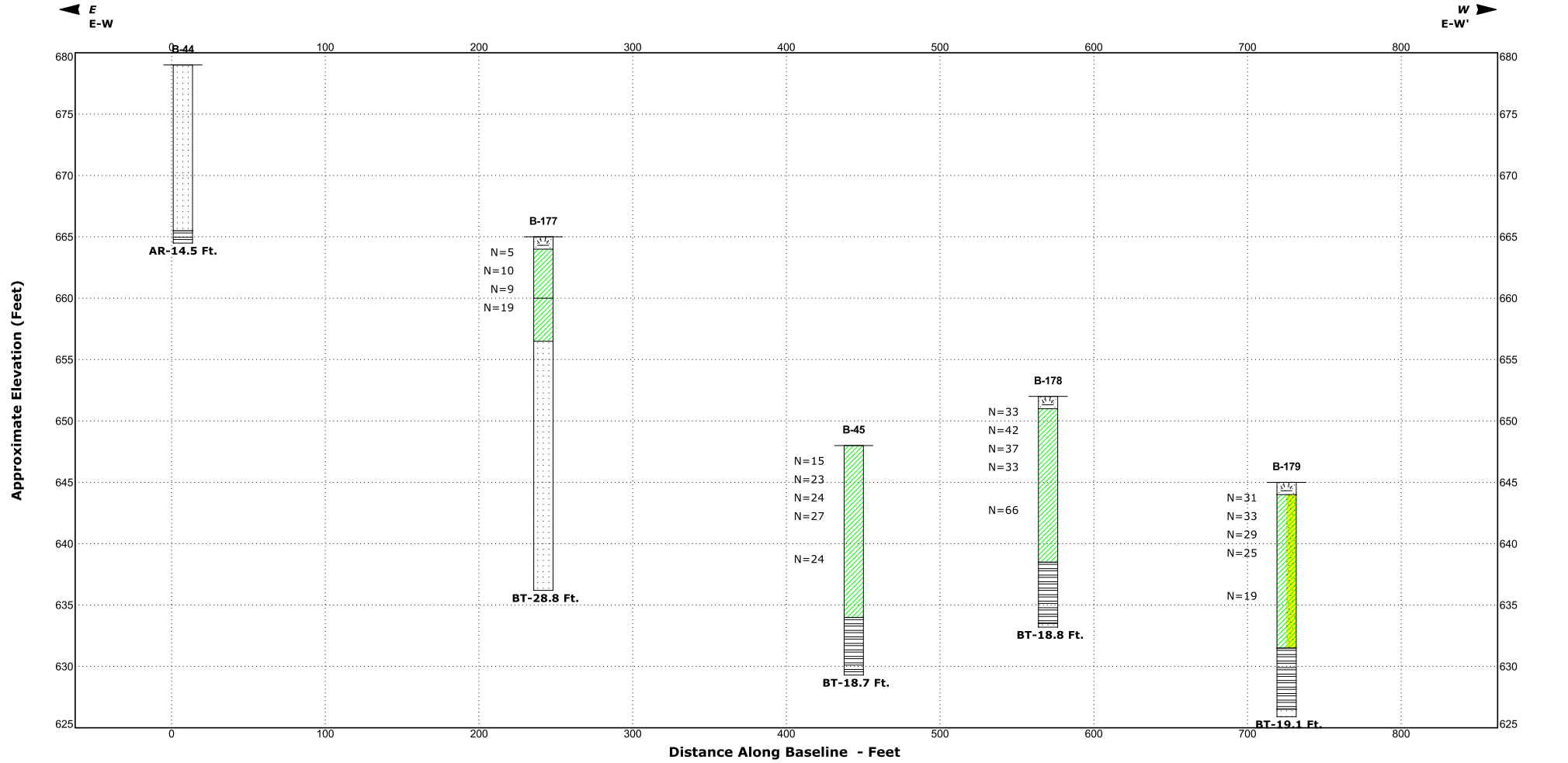
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-172 — Borehole Number Moisture Content — %w; LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay; Sandstone; Sandy Lean Clay; Shale; Silty Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC2A E-W #6

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



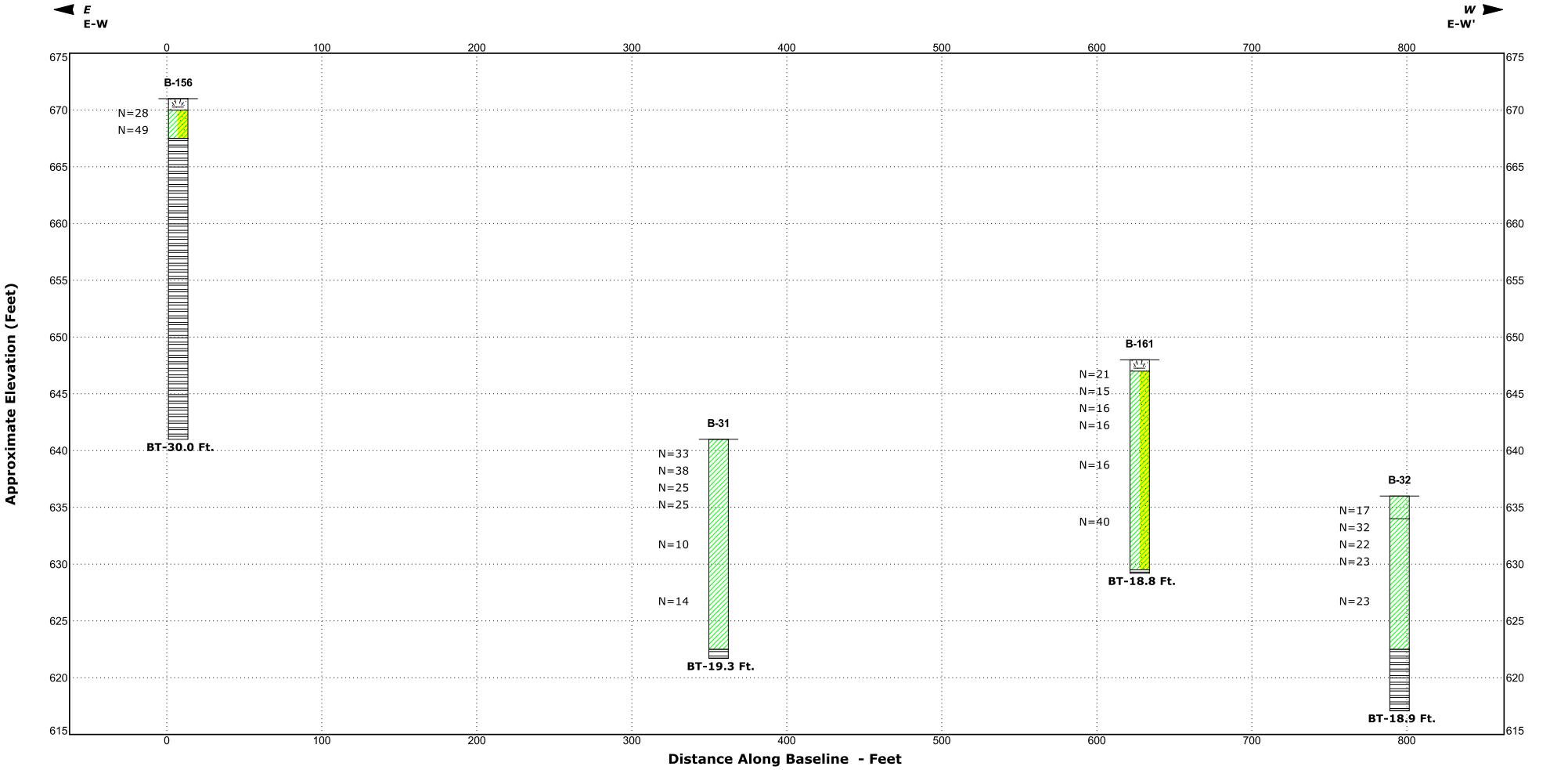
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-177 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR BT — Borehole Termination Type	Topsoil Lean Clay Sandstone Shale Lean Clay with Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC2A E-W #1

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



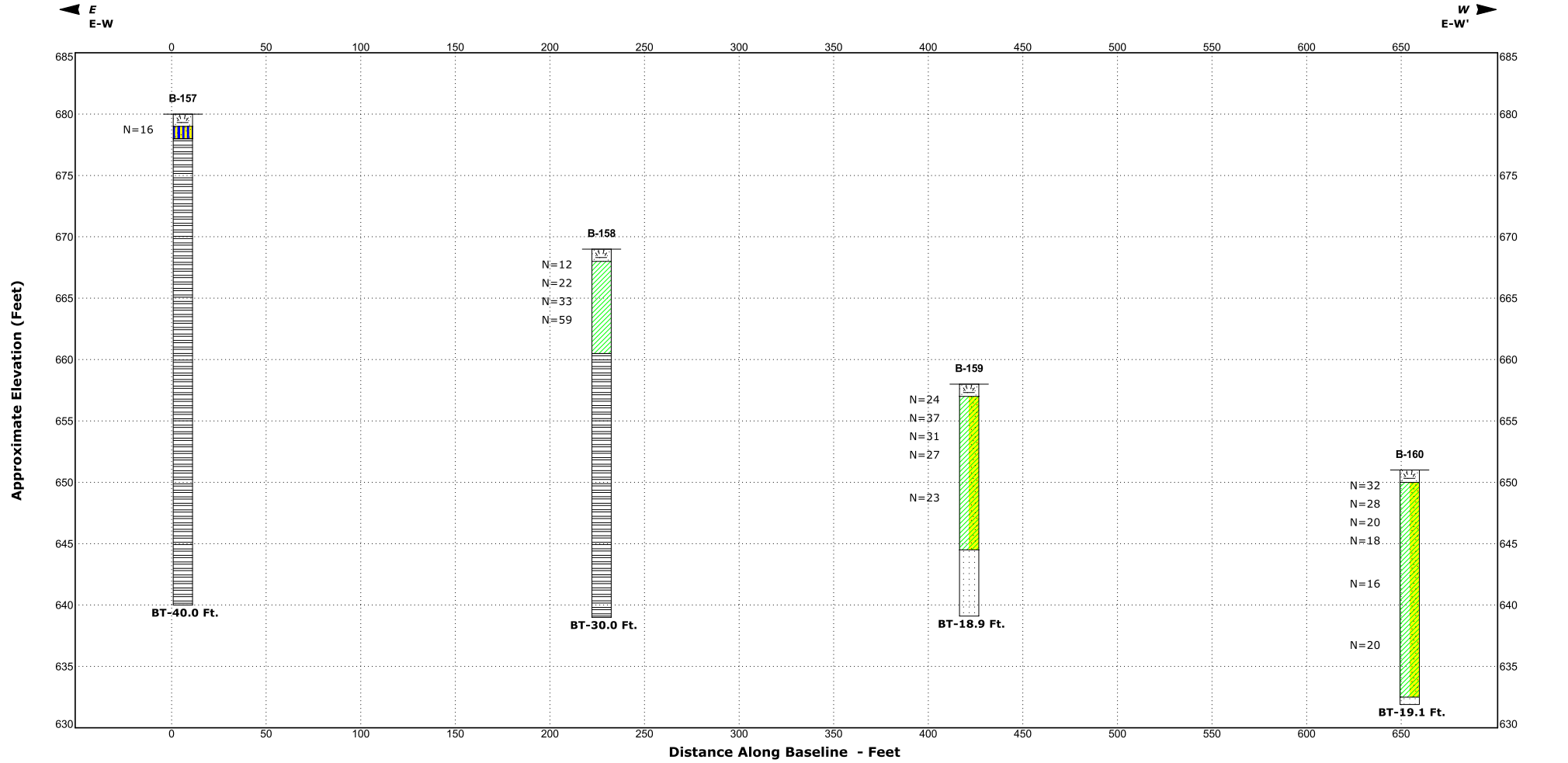
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-156 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR BT — Borehole Termination Type	Topsoil Lean Clay with Sand Shale Lean Clay

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC2A E-W #2

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



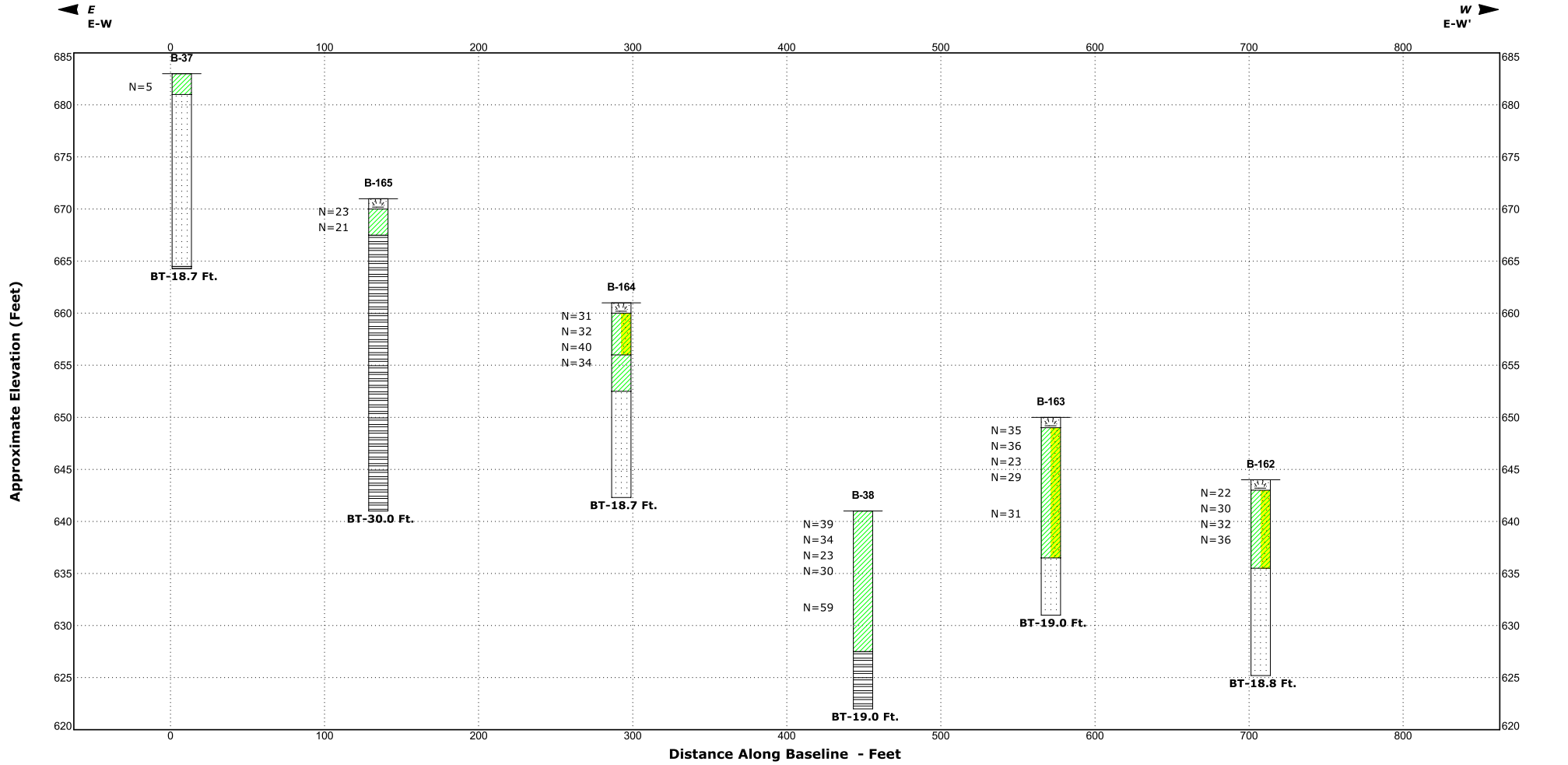
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-157 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil, Sandy Silt, Shale, Lean Clay, Lean Clay with Sand, Sandstone

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC2A E-W #3

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



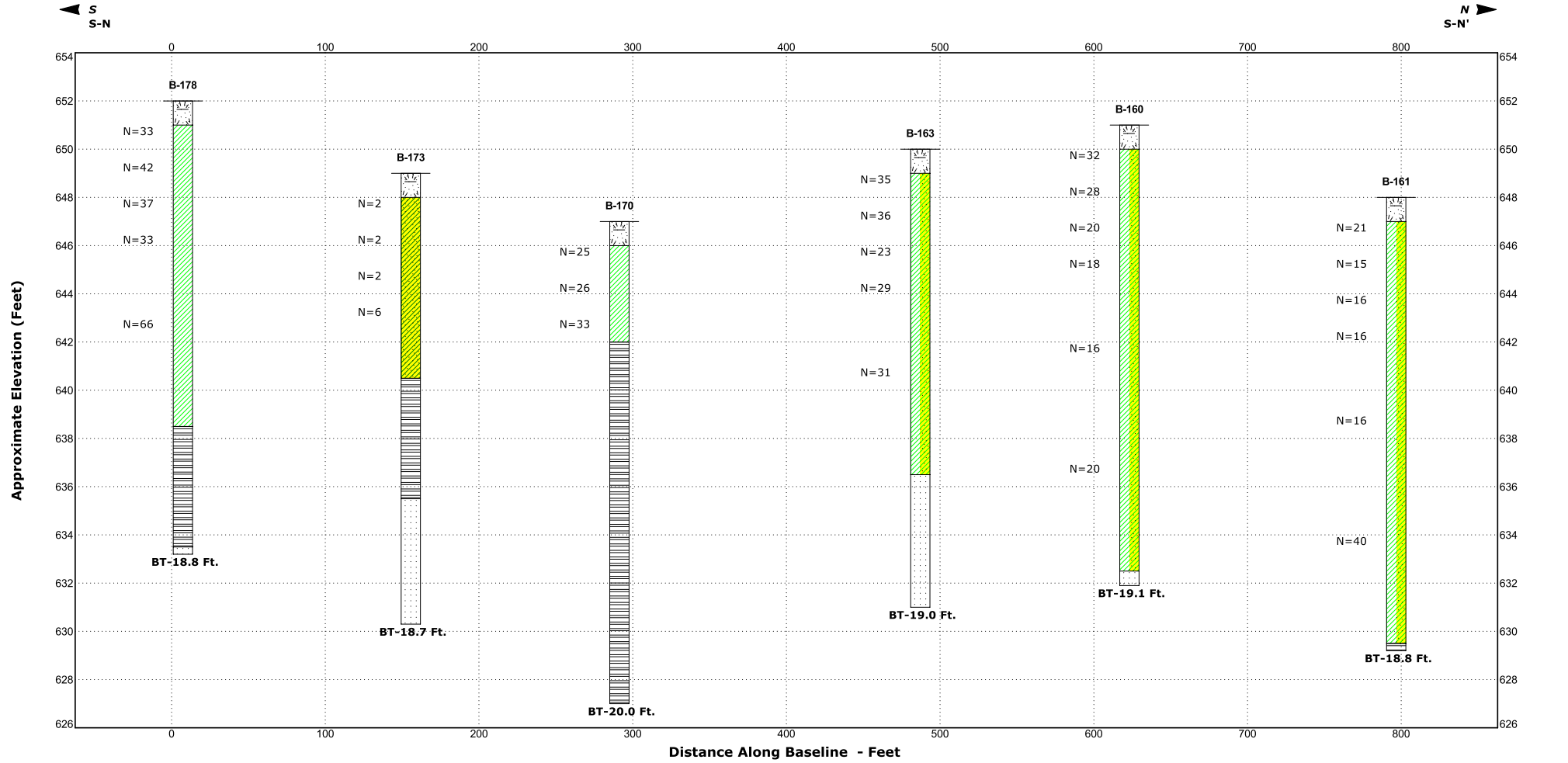
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-162 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay with Sand; Sandstone; Lean Clay; Shale

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC2A S-N #4

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



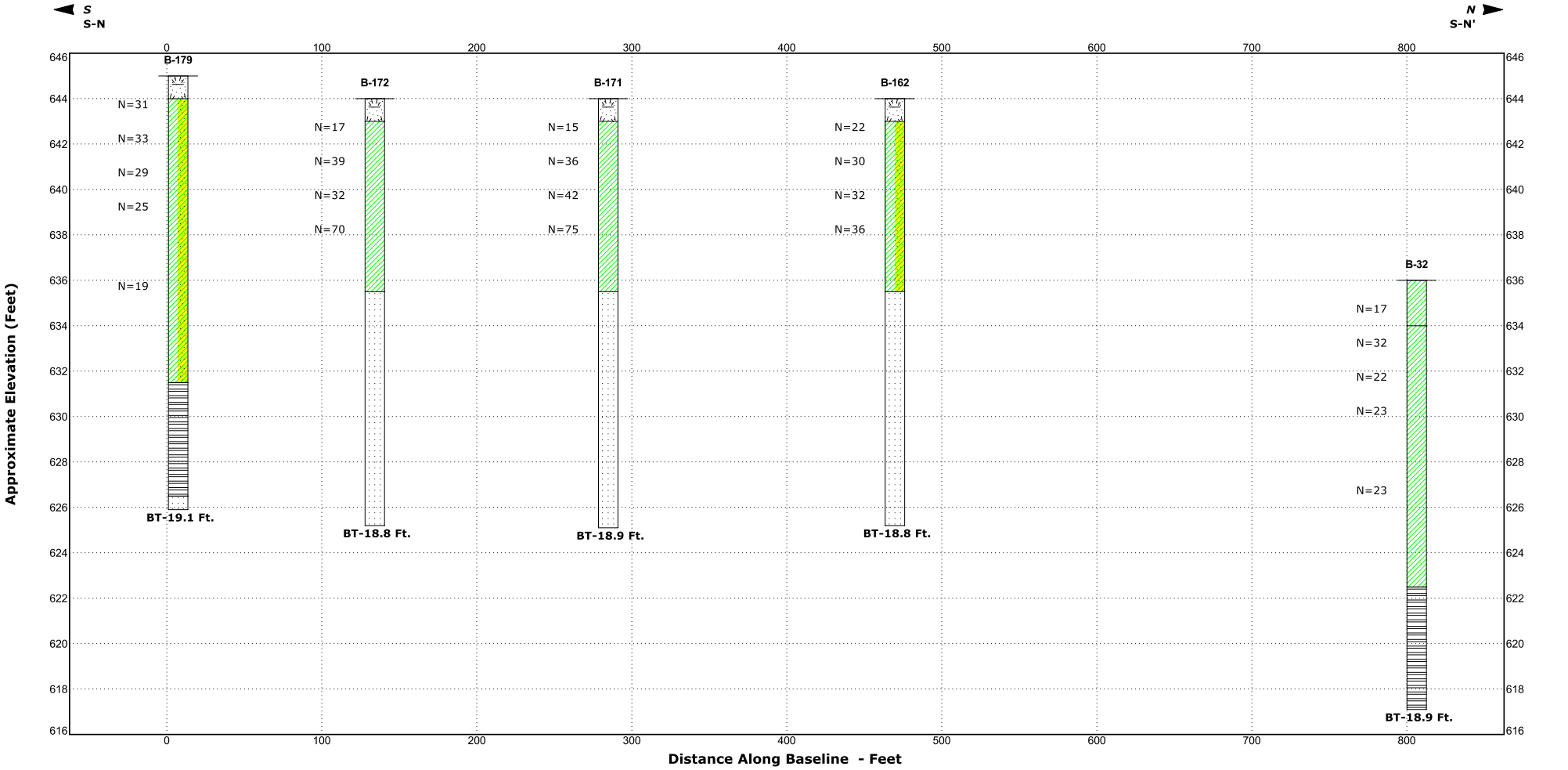
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-160 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR BT — Borehole Termination Type	Topsoil Lean Clay with Sand Sandstone Shale Lean Clay Sandy Lean Clay

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC2A S-N #5

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



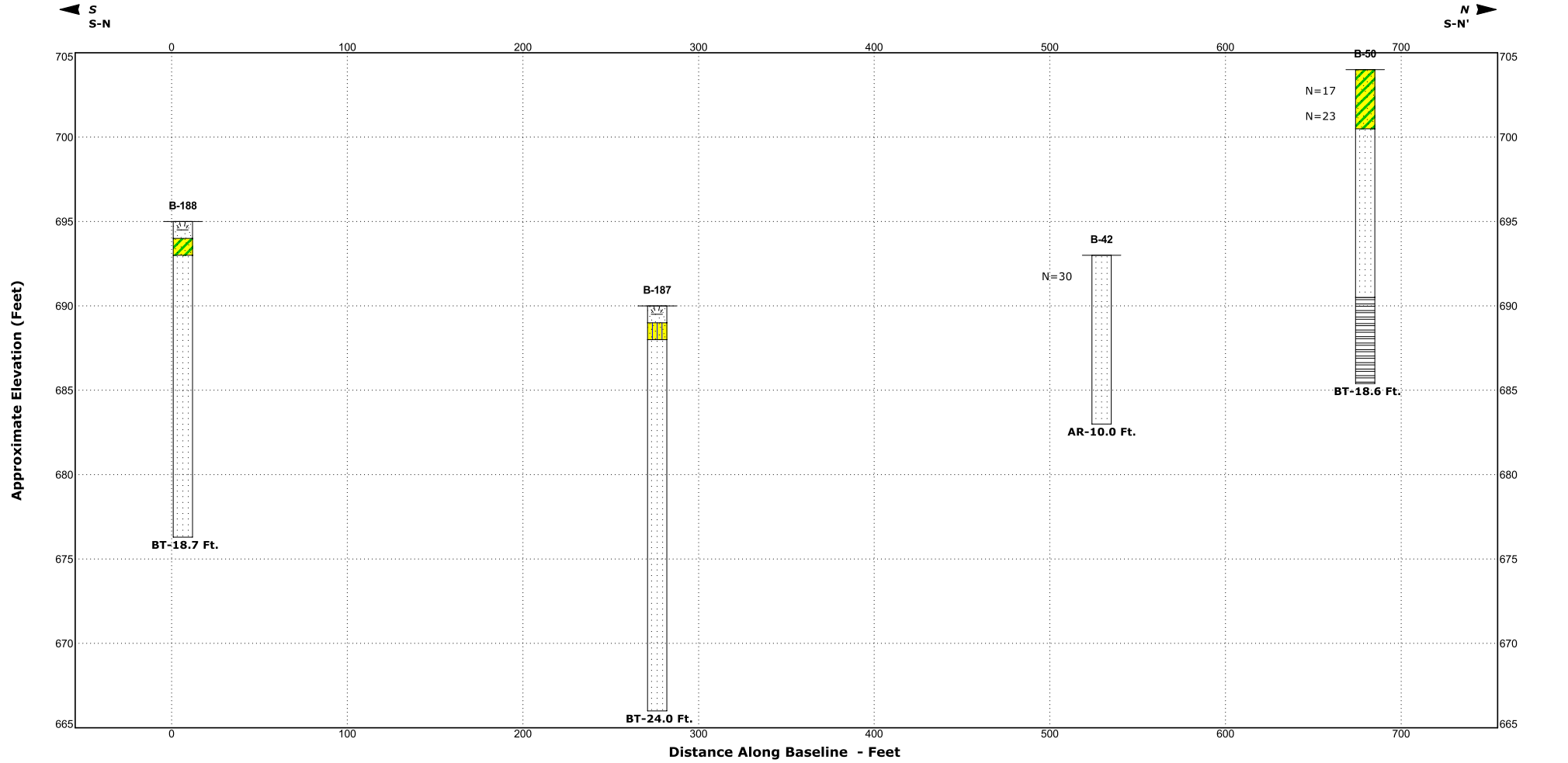
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-162 — Borehole Number Moisture Content — %w; LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay with Sand; Sandstone; Lean Clay; Shale

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

Switching Station S-N #1

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



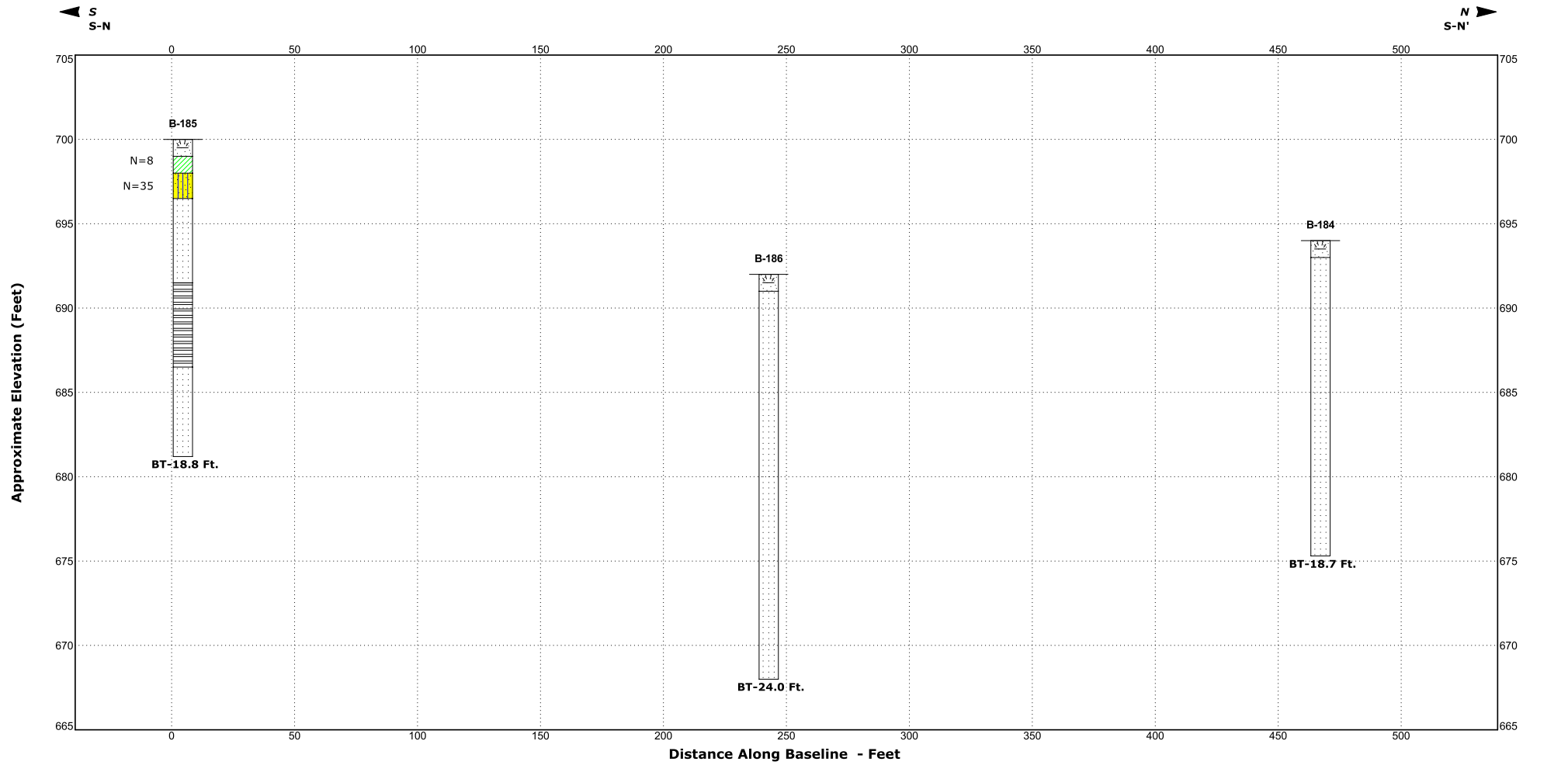
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-187 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil, Silty Sand, Sandstone, Clayey Sand, Shale

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

Switching Station S-N #2

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



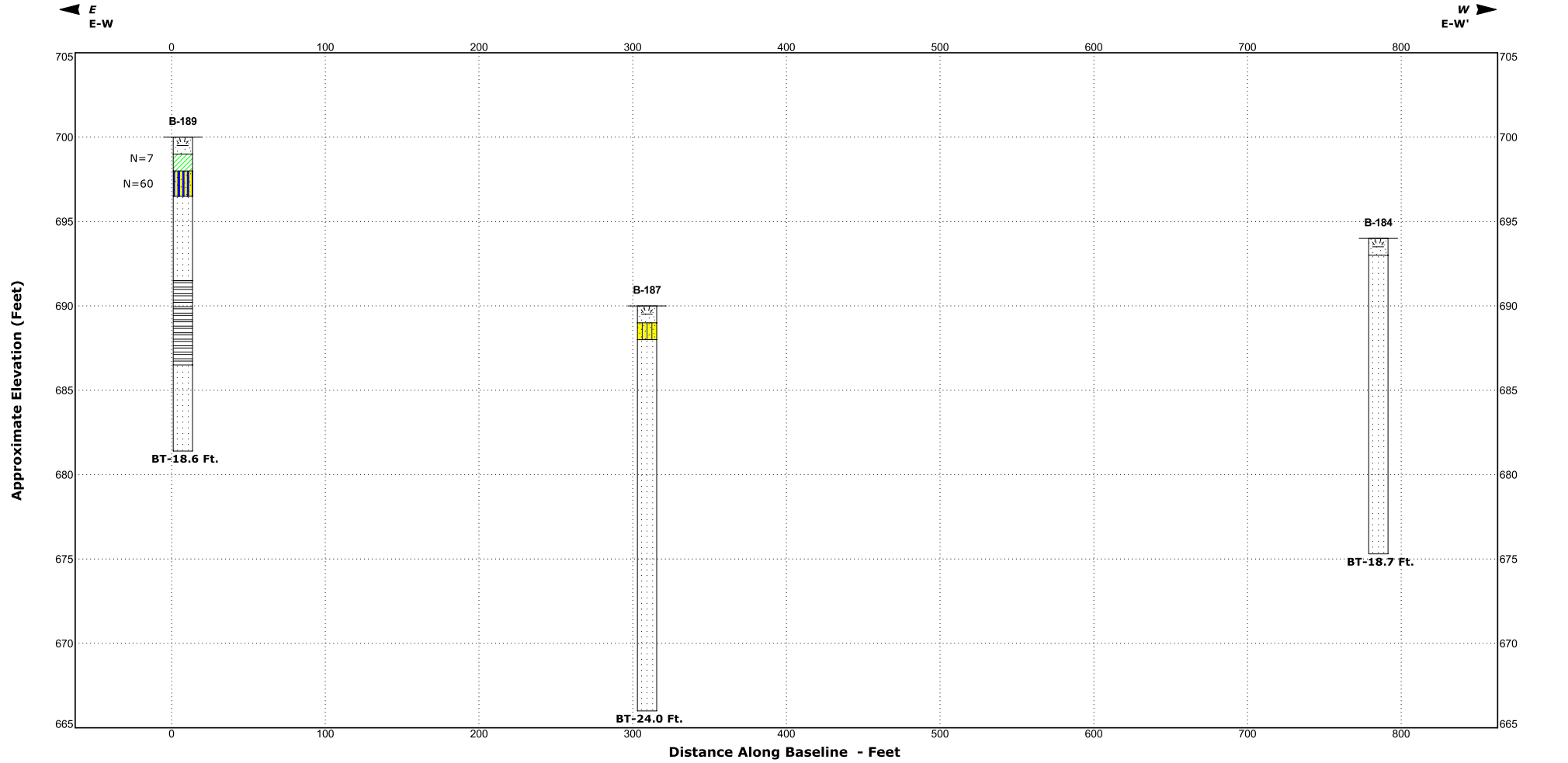
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-184 — Borehole Number Moisture Content — %w; LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Sandstone; Lean Clay; Silty Sand; Shale

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

Switching Station E-W #1

9522 E 47th Pl, Ste D
Tulsa, OK



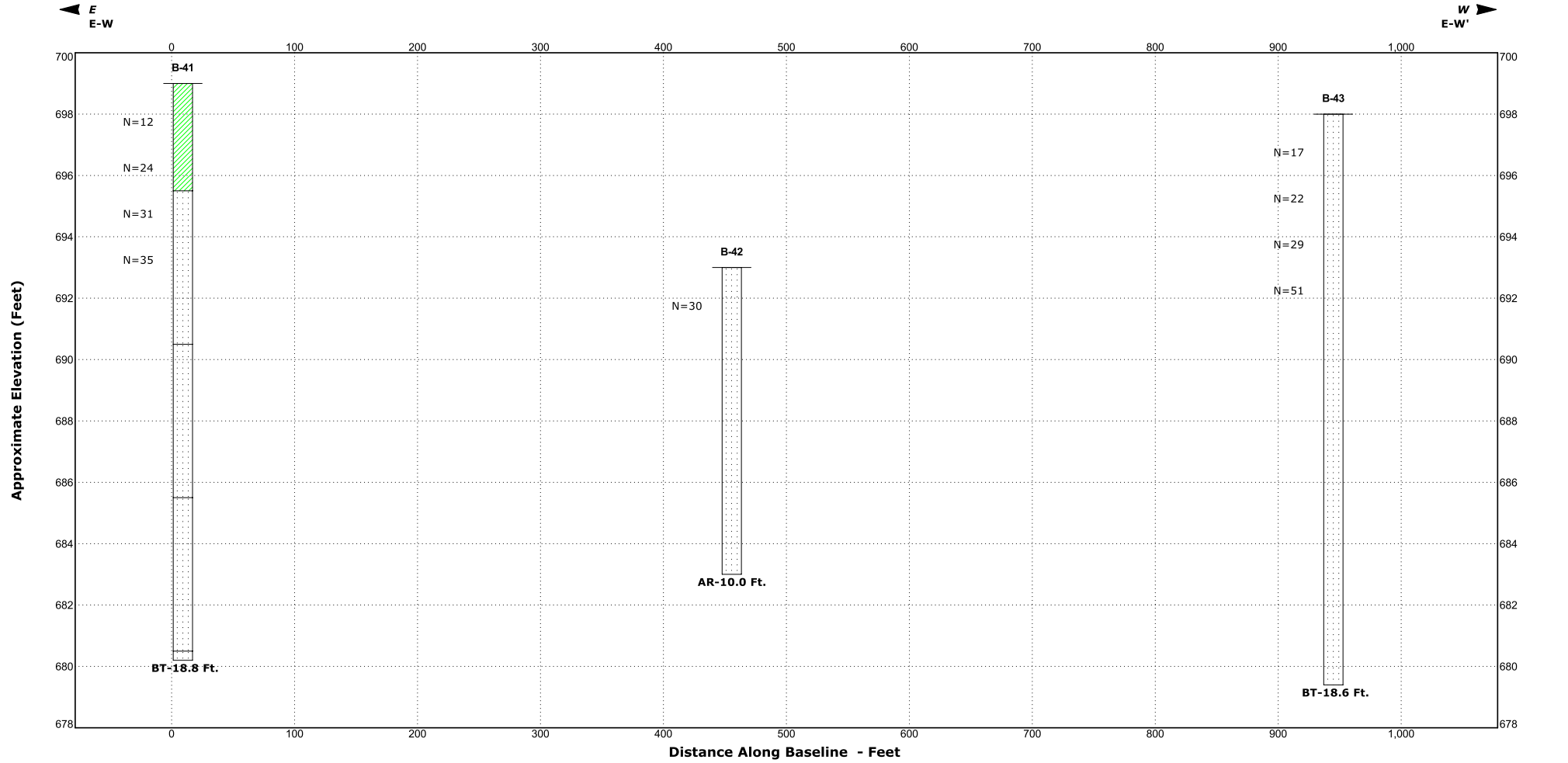
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-184 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR BT — Borehole Termination Type	Topsoil, Sandstone, Silty Sand, Lean Clay, Sandy Silt, Shale

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

Switching Station E-W #2

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



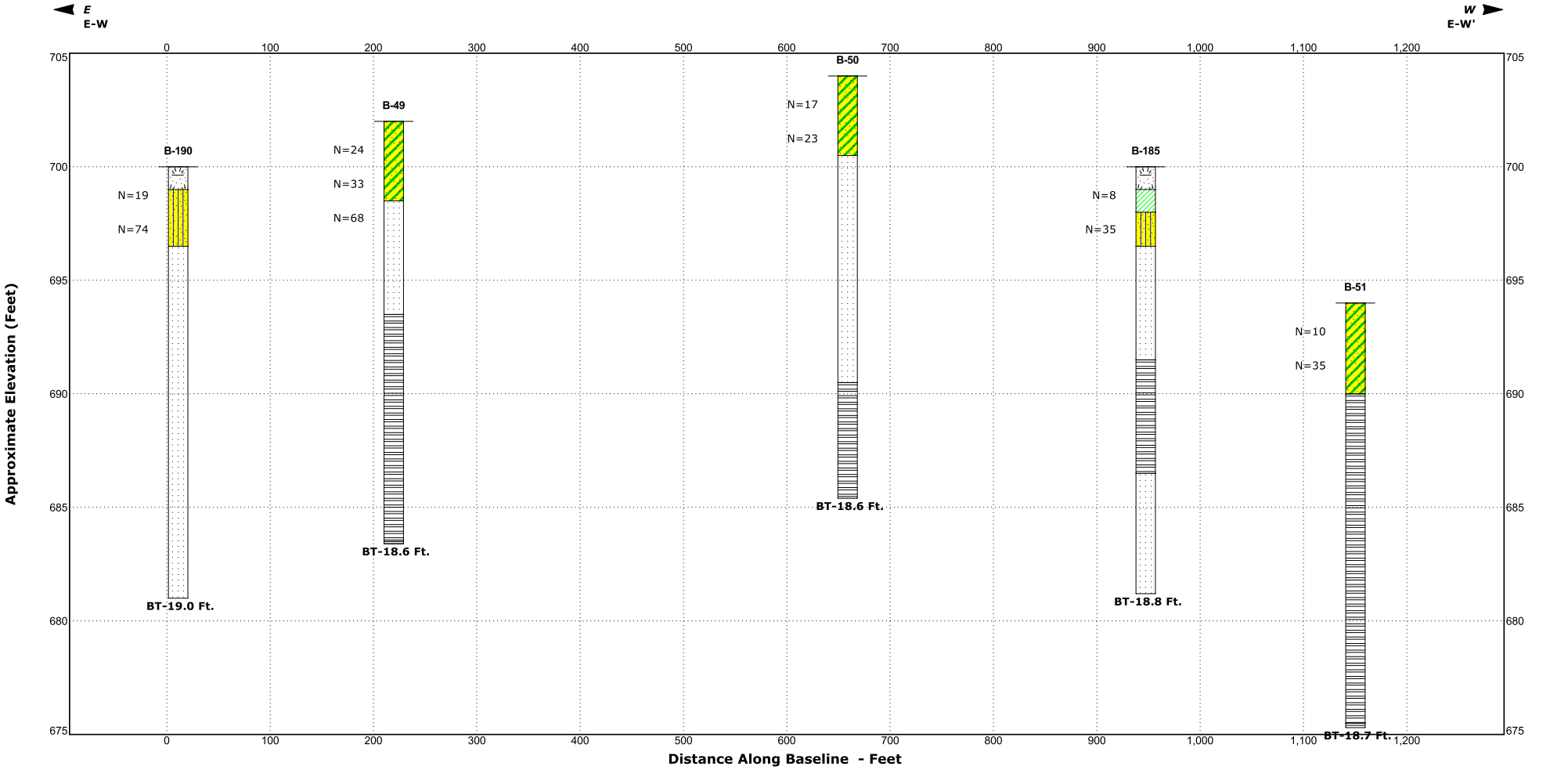
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-41 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR BT — Borehole Termination Type	Lean Clay Sandstone

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

Switching Station E-W #3

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



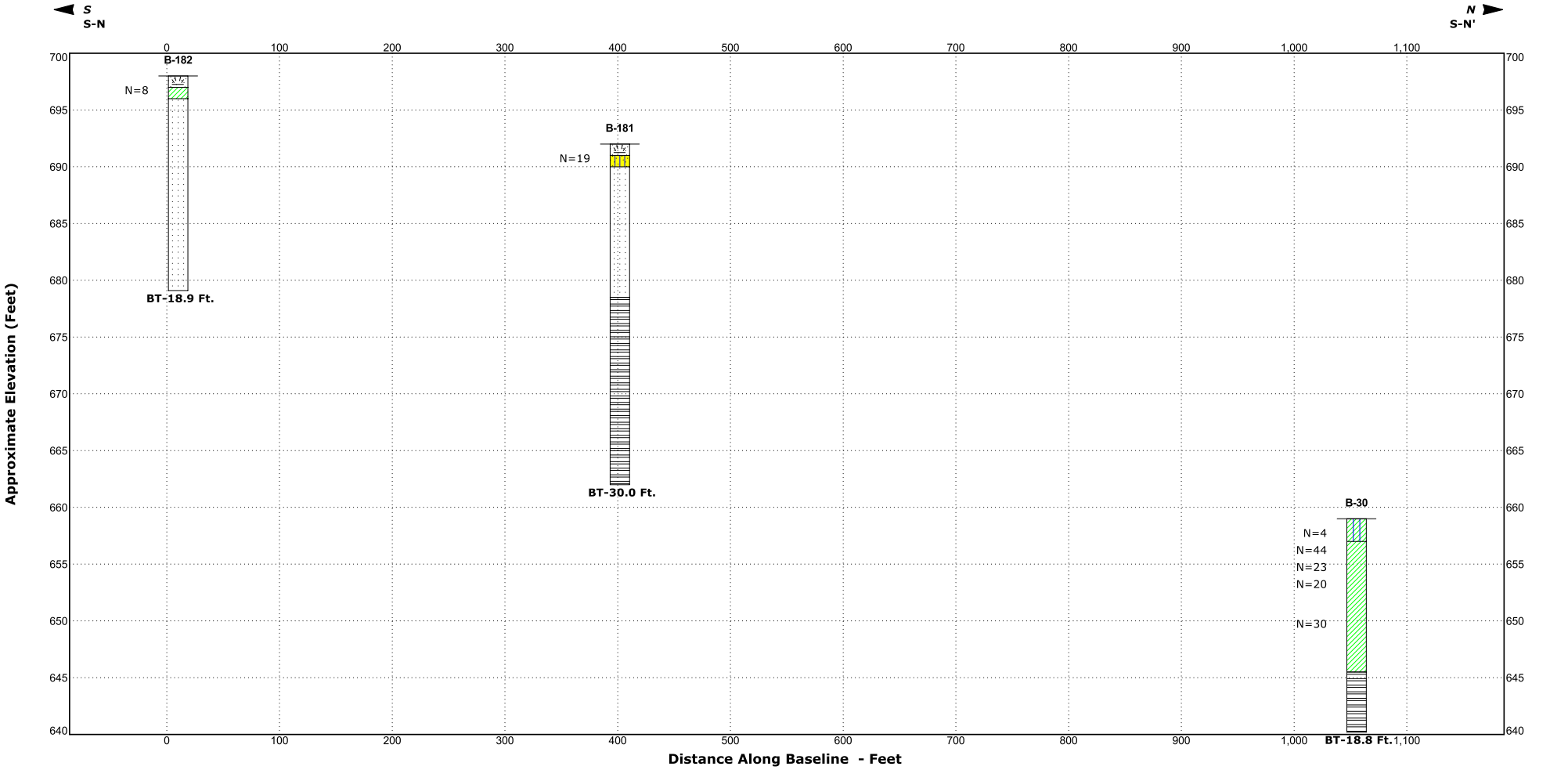
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-185 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil, Lean Clay, Silty Sand, Sandstone, Shale, Clayey Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

Phase 2 Spine Road

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-181 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR BT — Borehole Termination Type	Topsoil, Silty Sand, Sandstone, Shale, Lean Clay, Silty Clay

Phase 3 Fence Lines

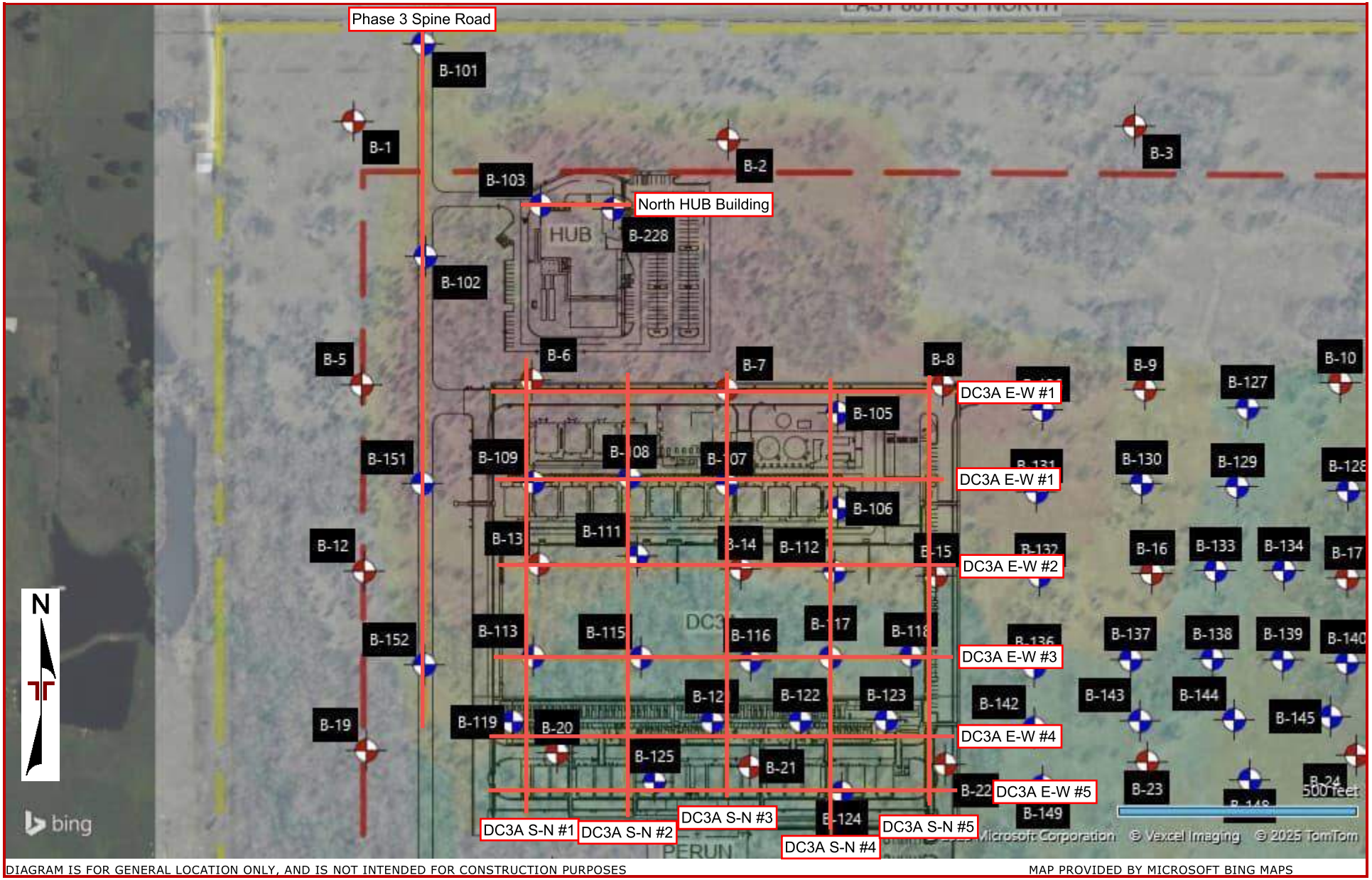


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

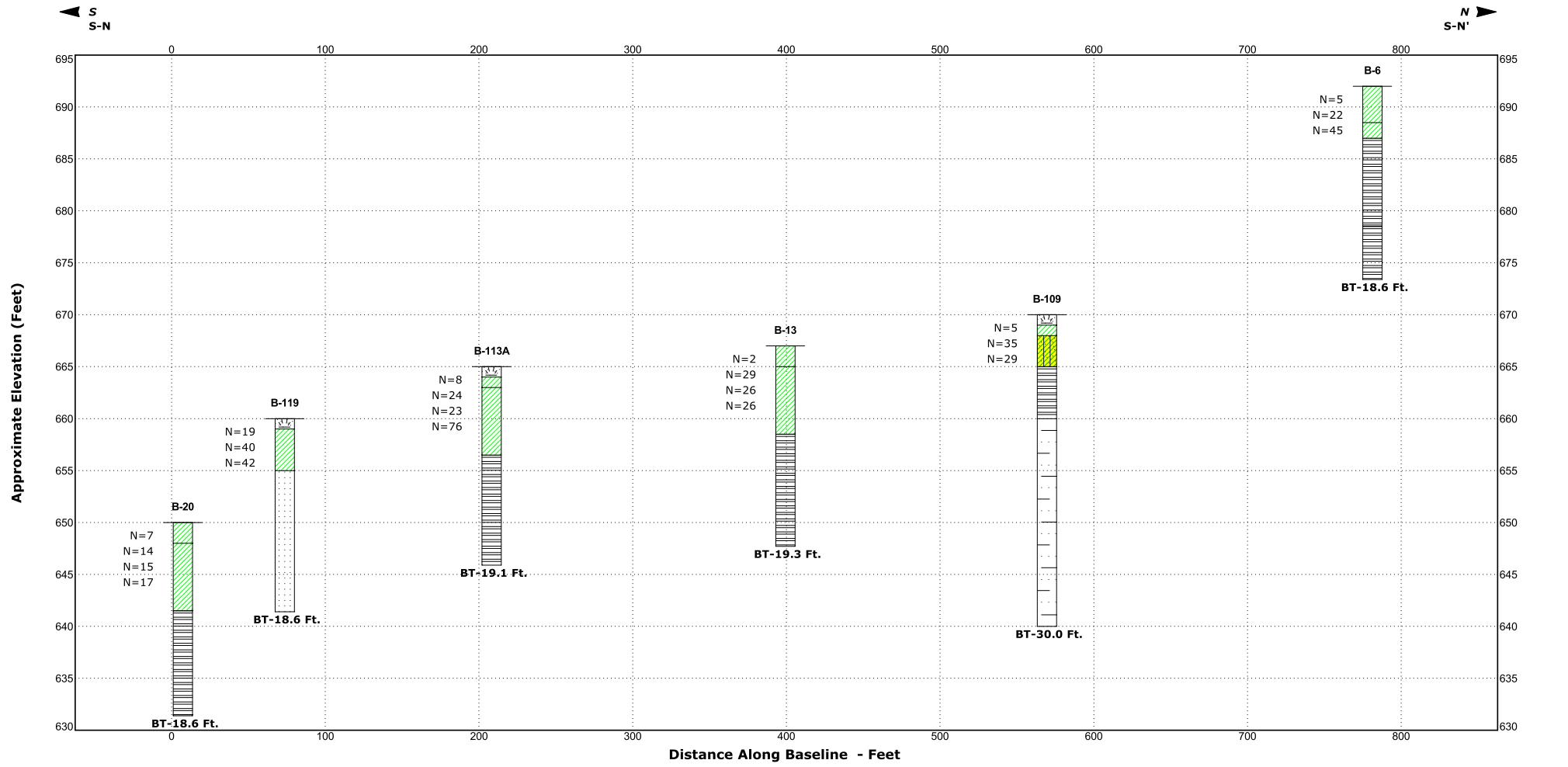
MAP PROVIDED BY MICROSOFT BING MAPS

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC3A S-N #1

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



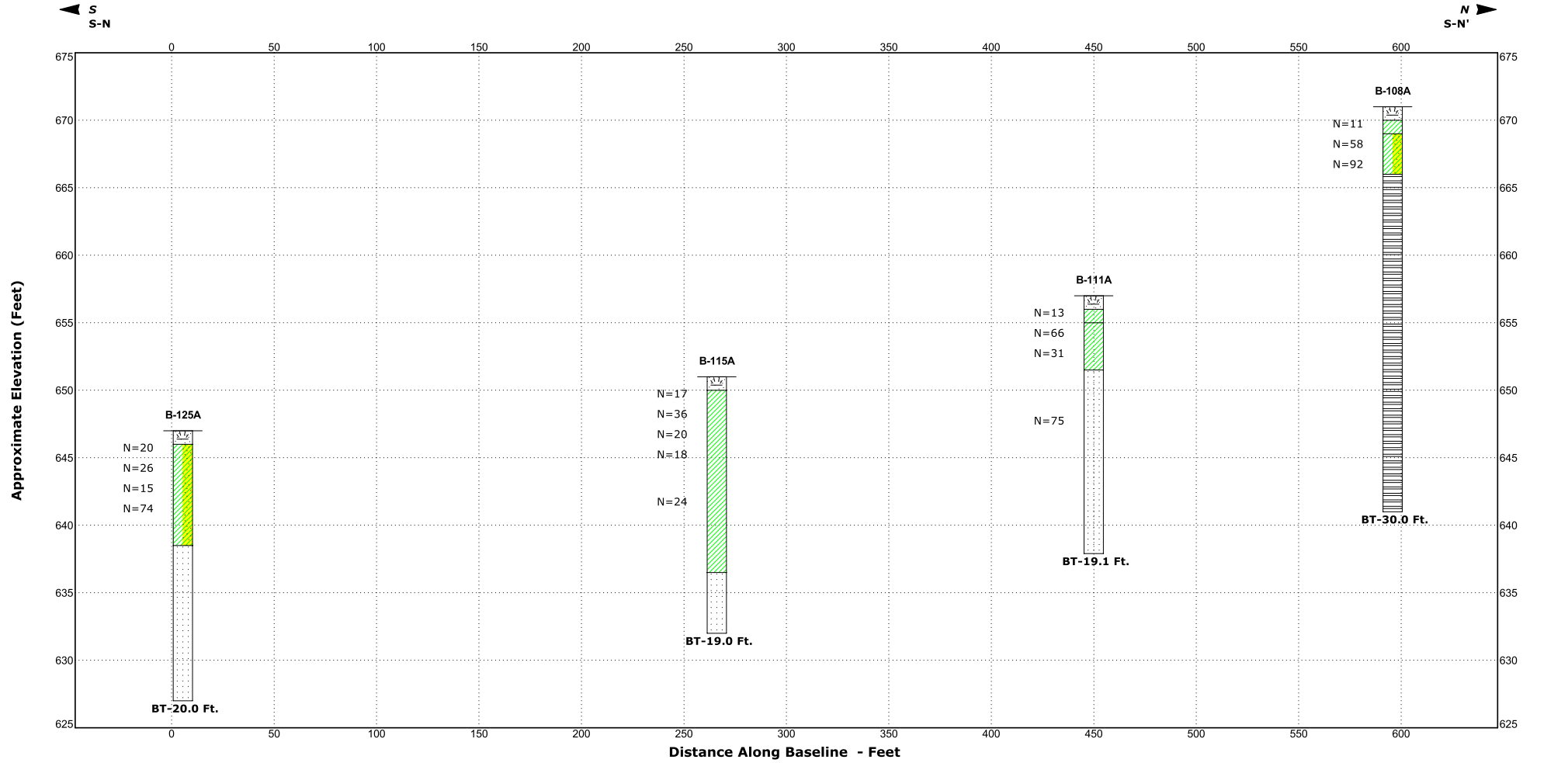
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-6 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR BT — Borehole Termination Type	Lean Clay Shale Topsoil Sandy Silty Clay Interbedded Sandstone and Shale Sandstone

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC3A S-N #2

9522 E 47th Pl, Ste D
Tulsa, OK



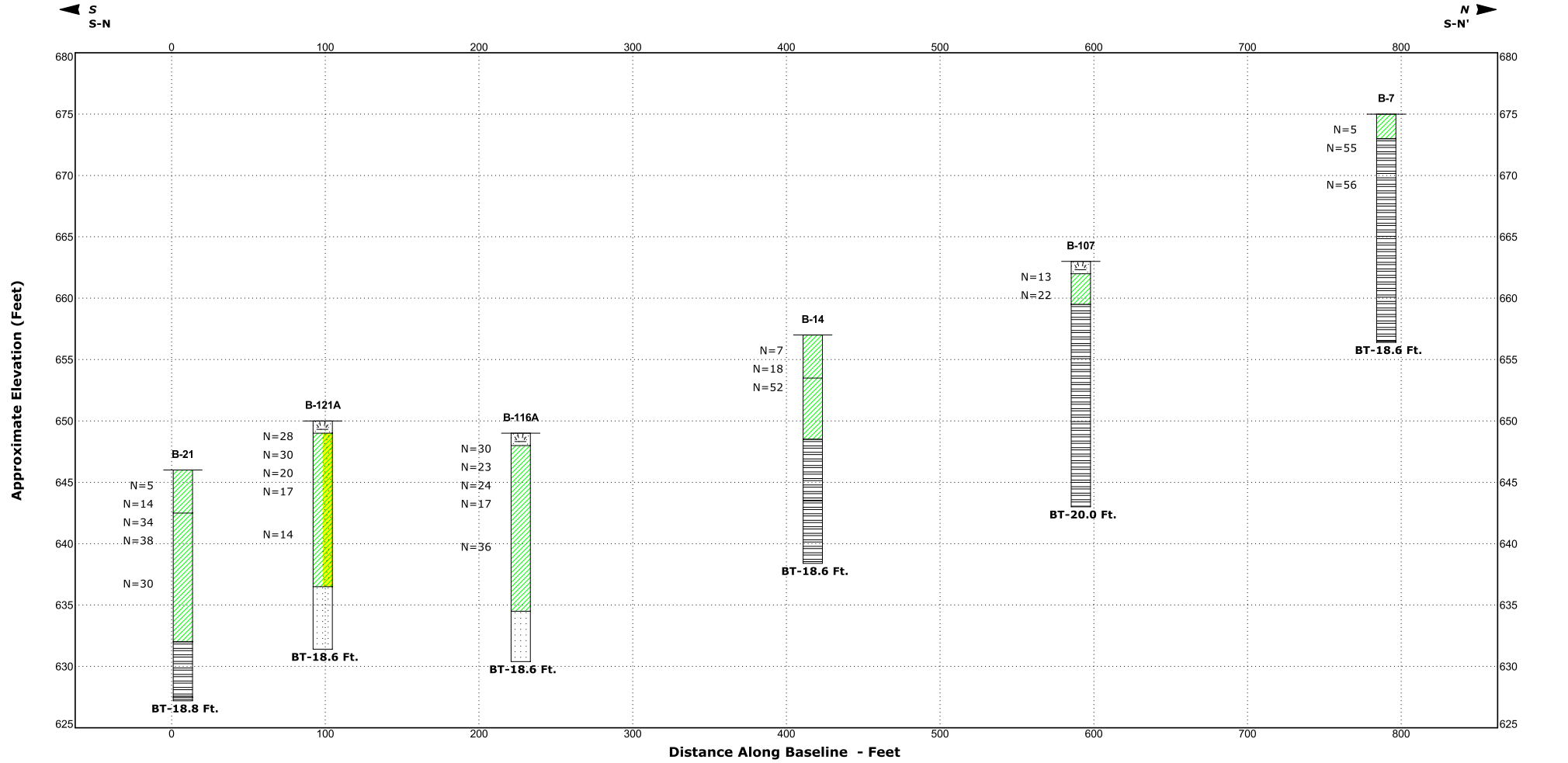
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-108A — Borehole Number Moisture Content — %w — LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay; Lean Clay with Sand; Shale; Sandstone

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC3A S-N #3

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



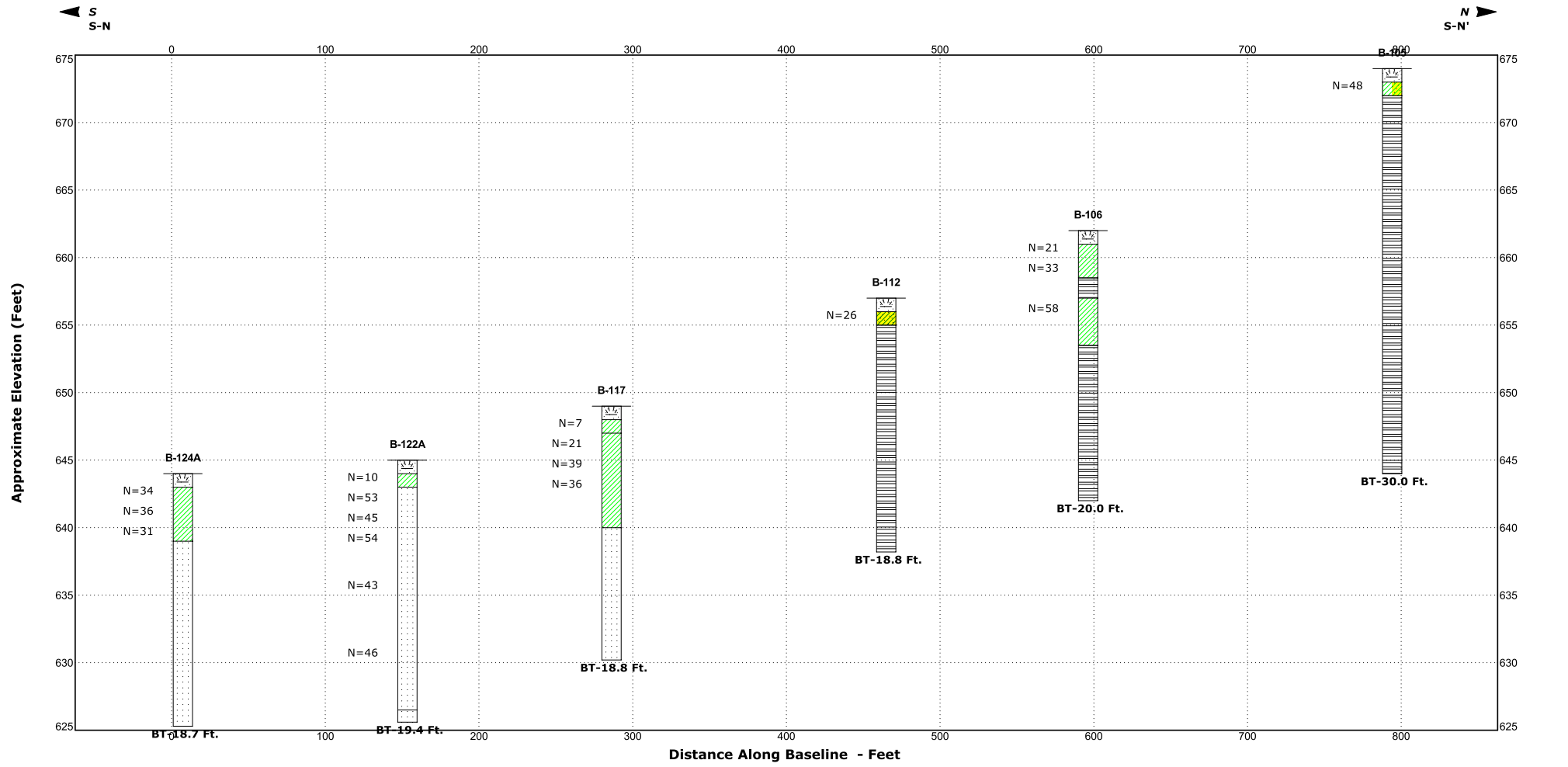
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-107 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay; Shale; Sandstone; Lean Clay with Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC3A S-N #4

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



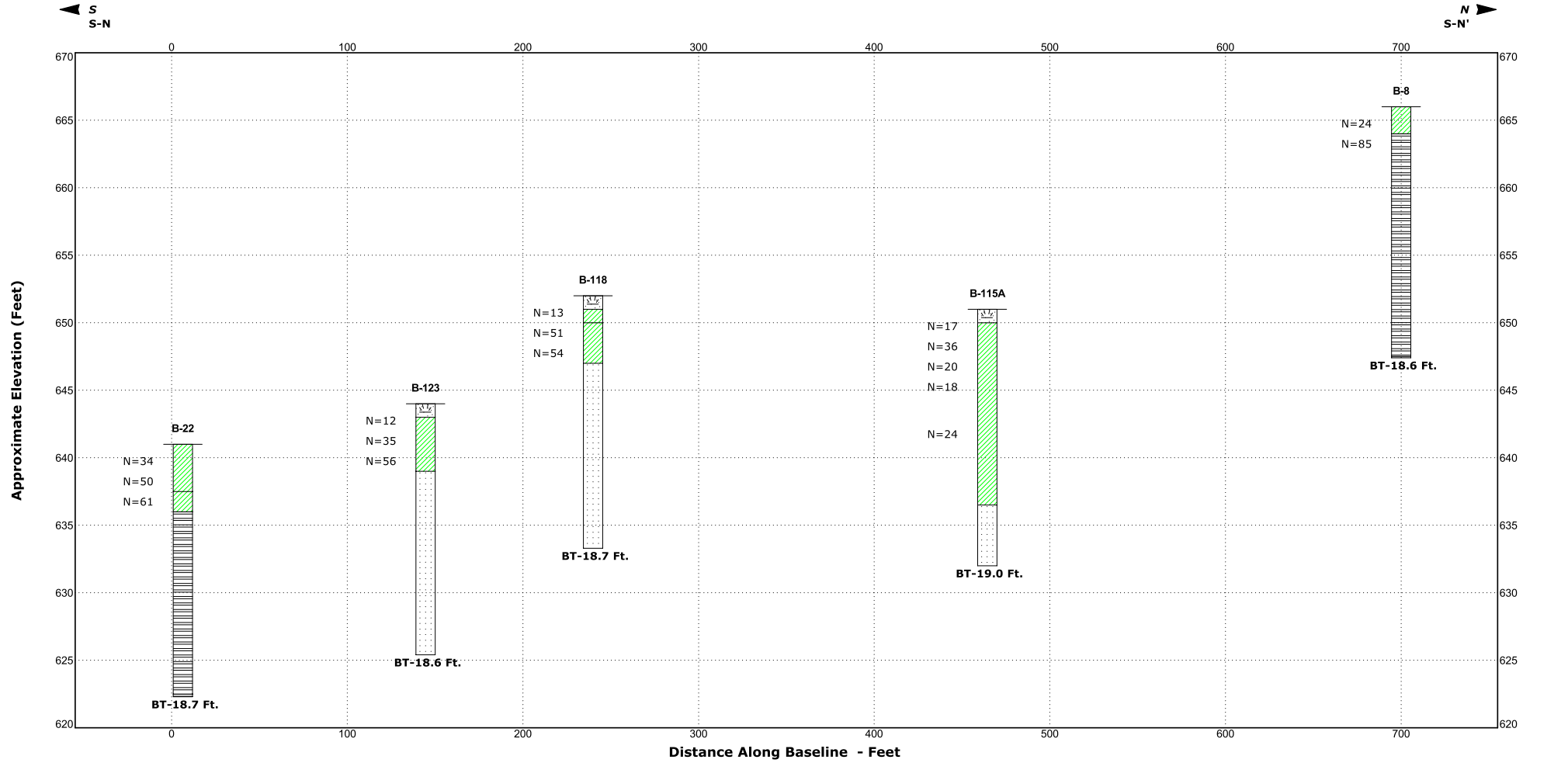
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-105 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay with Sand; Shale; Lean Clay; Sandy Lean Clay; Sandstone

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC3A S-N #5

9522 E 47th Pl, Ste D
Tulsa, OK



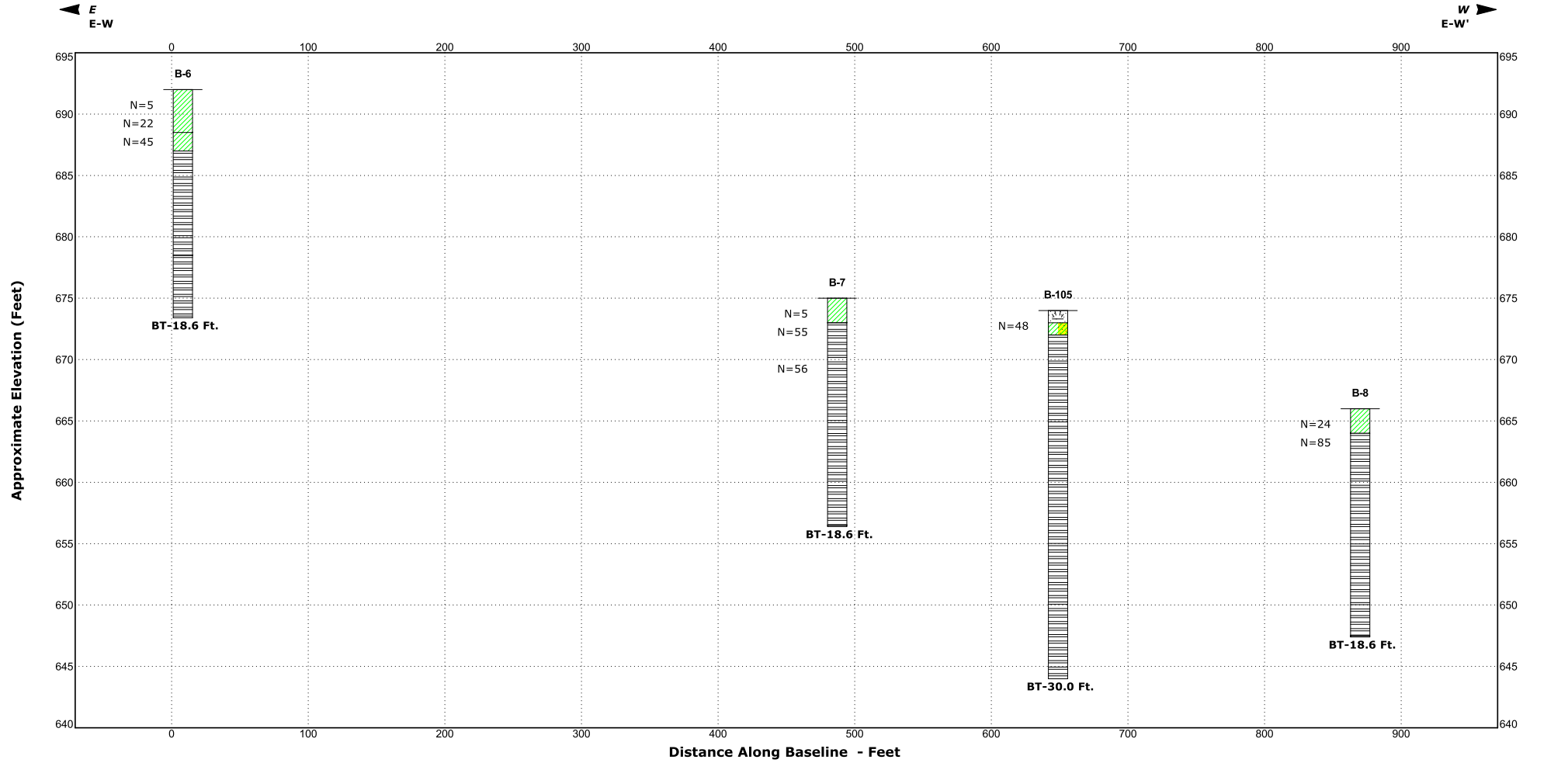
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-8 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Lean Clay, Shale, Topsoil, Sandstone

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC3A E-W #1

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



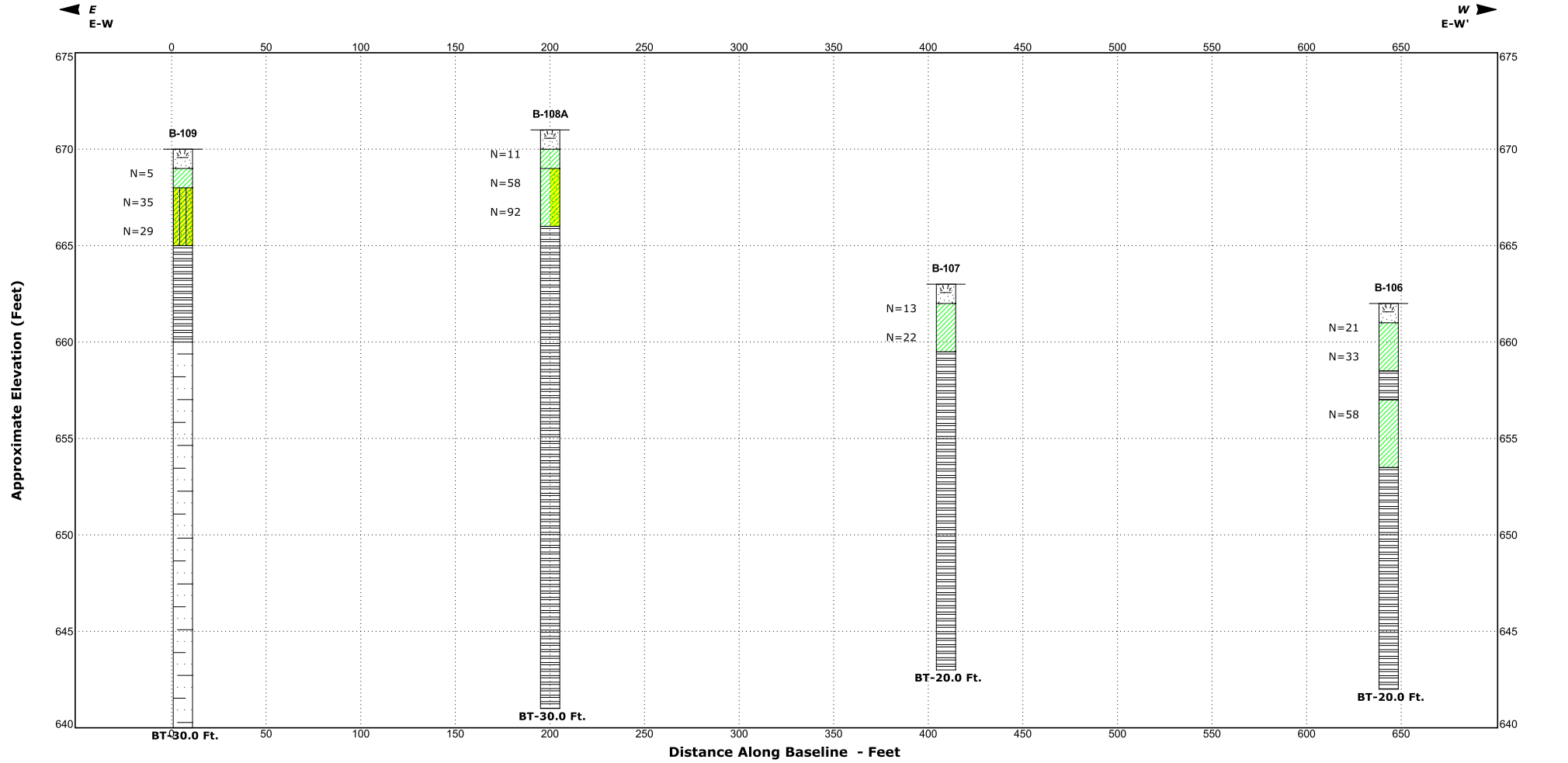
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-105 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay with Sand; Shale; Lean Clay

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC3A E-W #2

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



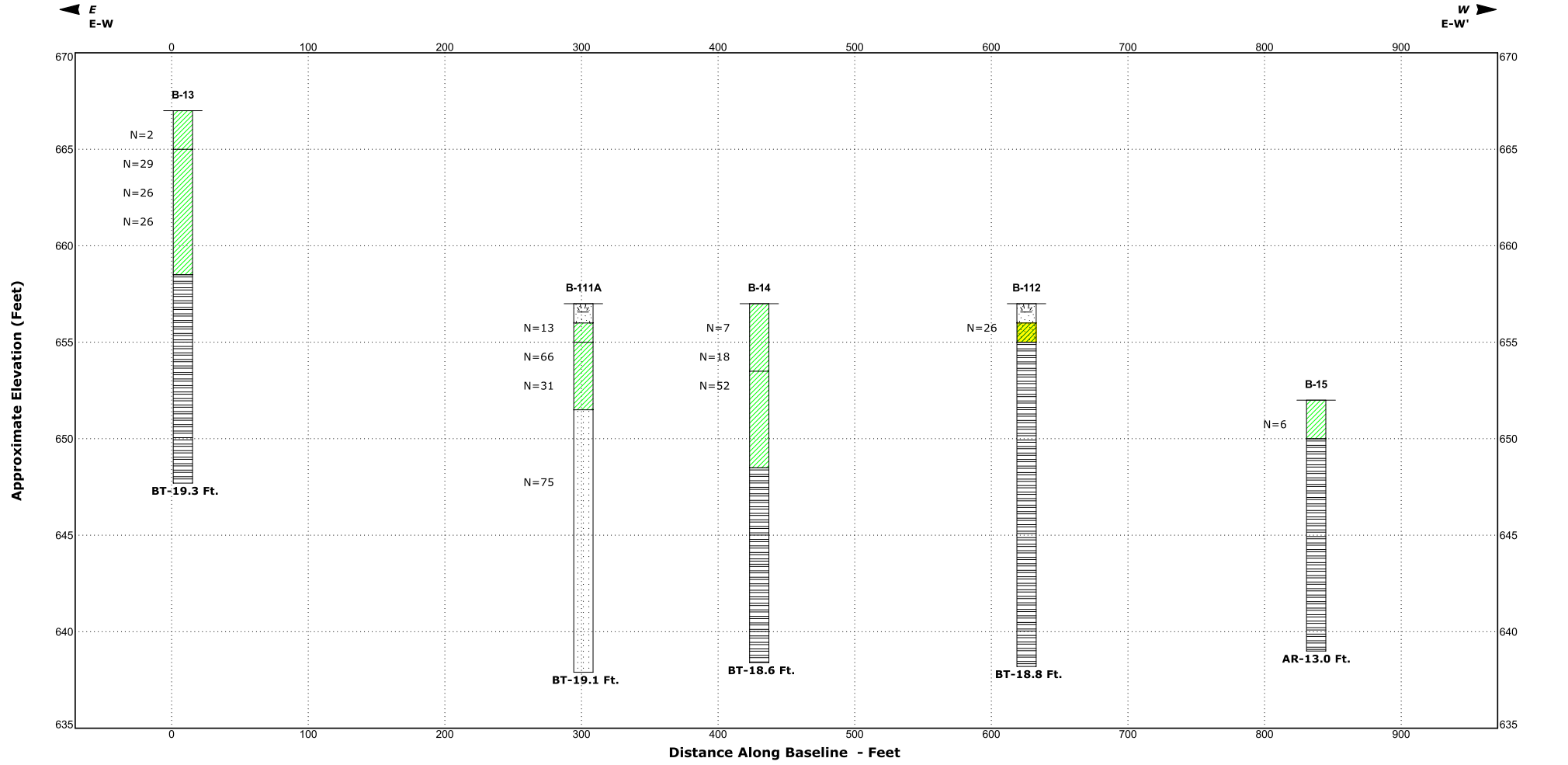
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-106 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay; Shale; Lean Clay with Sand; Sandy Silty Clay; Interbedded Sandstone and Shale

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC3A E-W #3

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



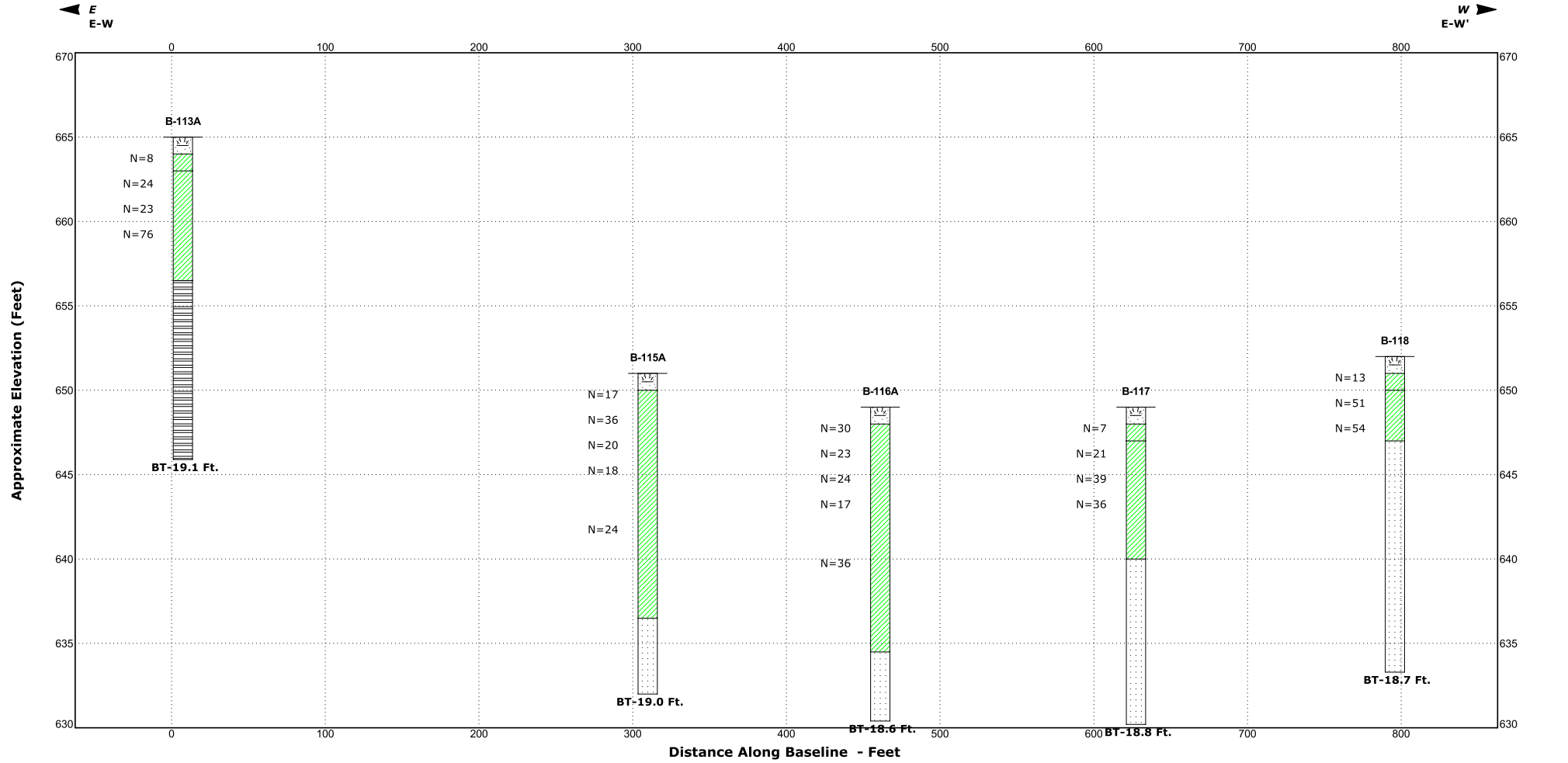
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-111A — Borehole Number Moisture Content — %w; LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay; Sandstone; Sandy Lean Clay; Shale

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC3A E-W #4

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



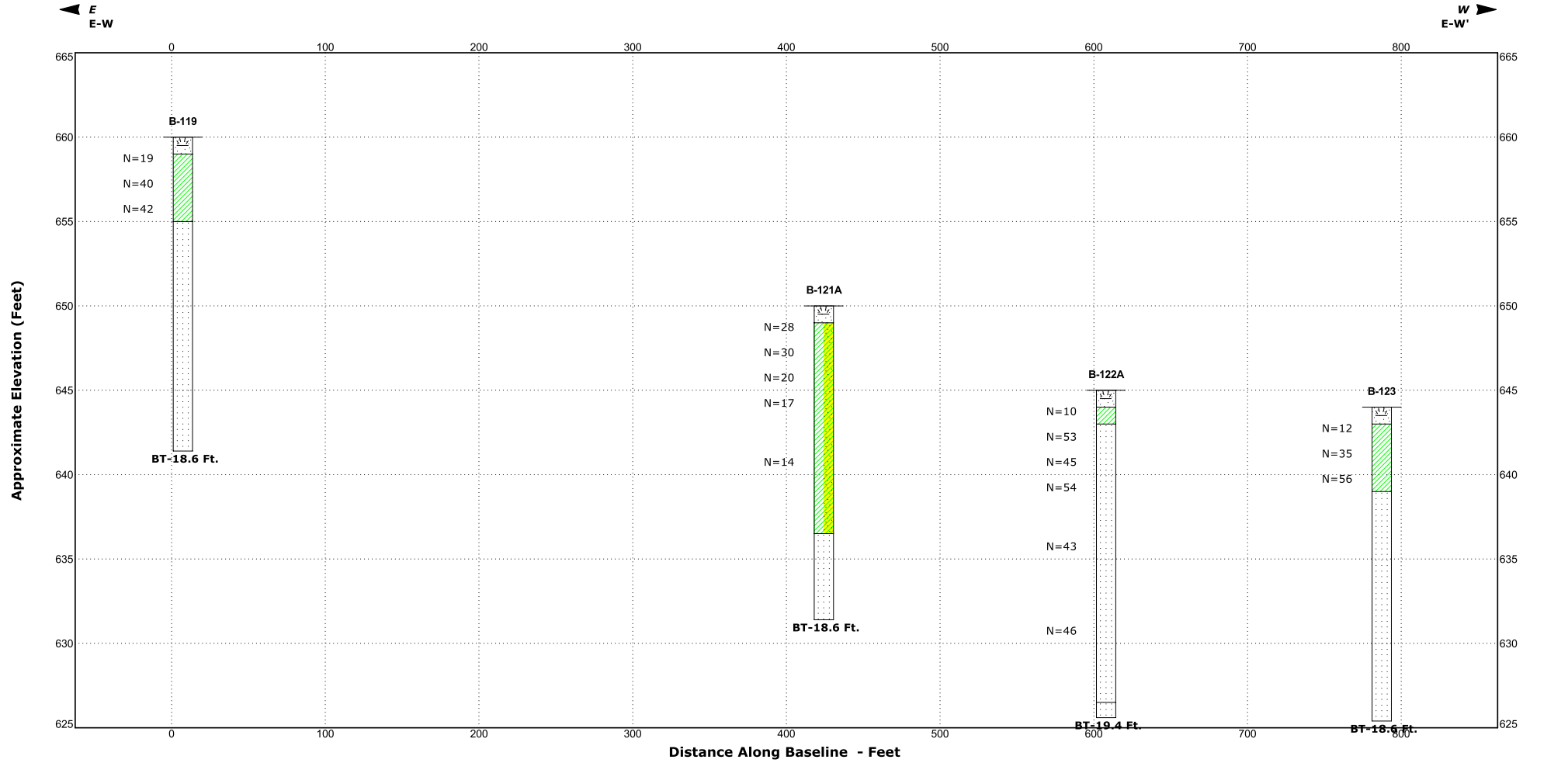
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-113A — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) Borehole Lithology AR BT — Borehole Termination Type	Topsoil Lean Clay Shale Sandstone

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC3A E-W #5

9522 E 47th Pl, Ste D
Tulsa, OK



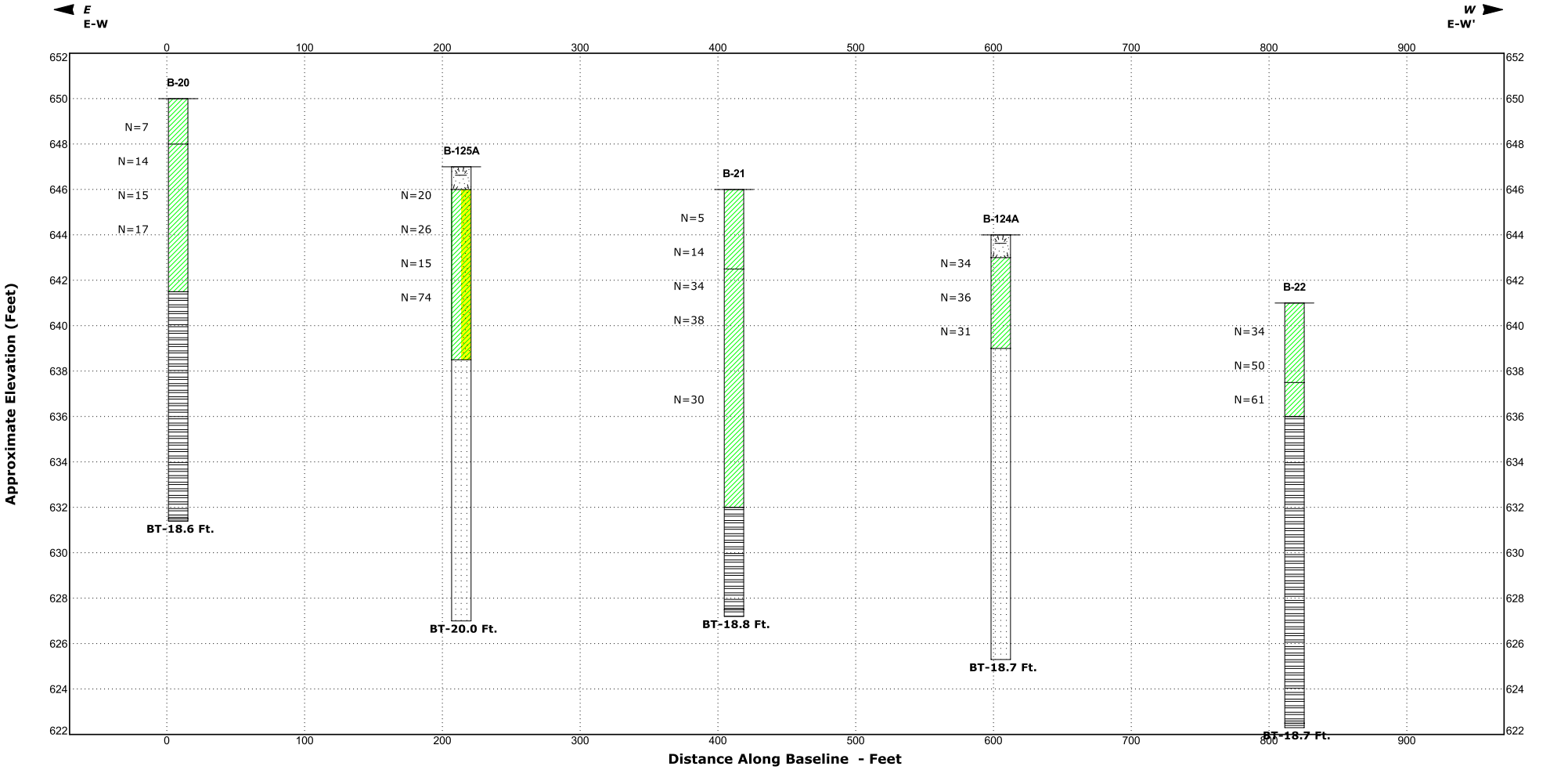
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-119 — Borehole Number Moisture Content — %w; LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay; Sandstone; Lean Clay with Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

DC3A E-W #6

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



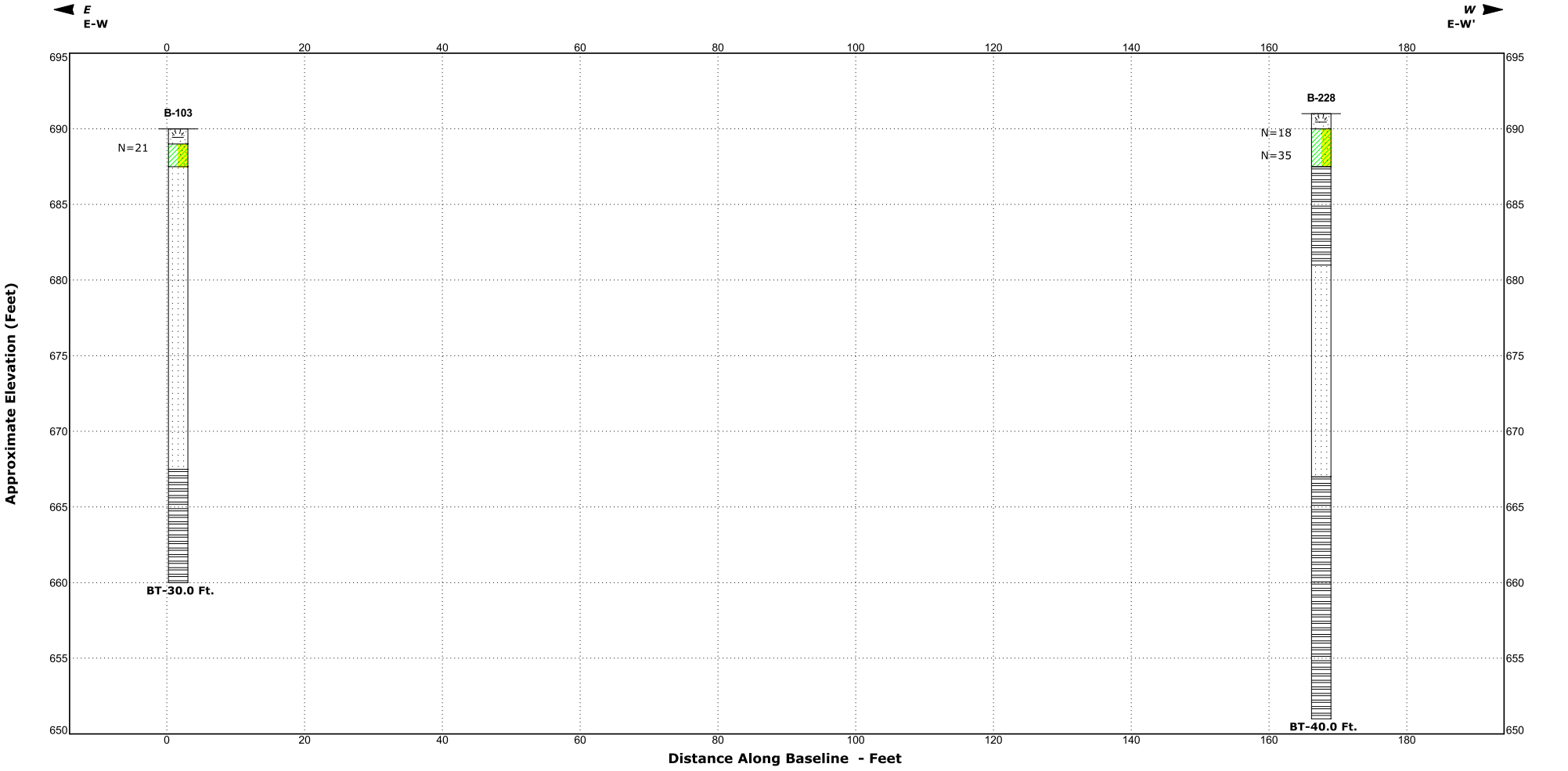
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-20 — Borehole Number Moisture Content — %w; LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Lean Clay; Shale; Topsoil; Sandstone; Lean Clay with Sand

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

North HUB Building

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK



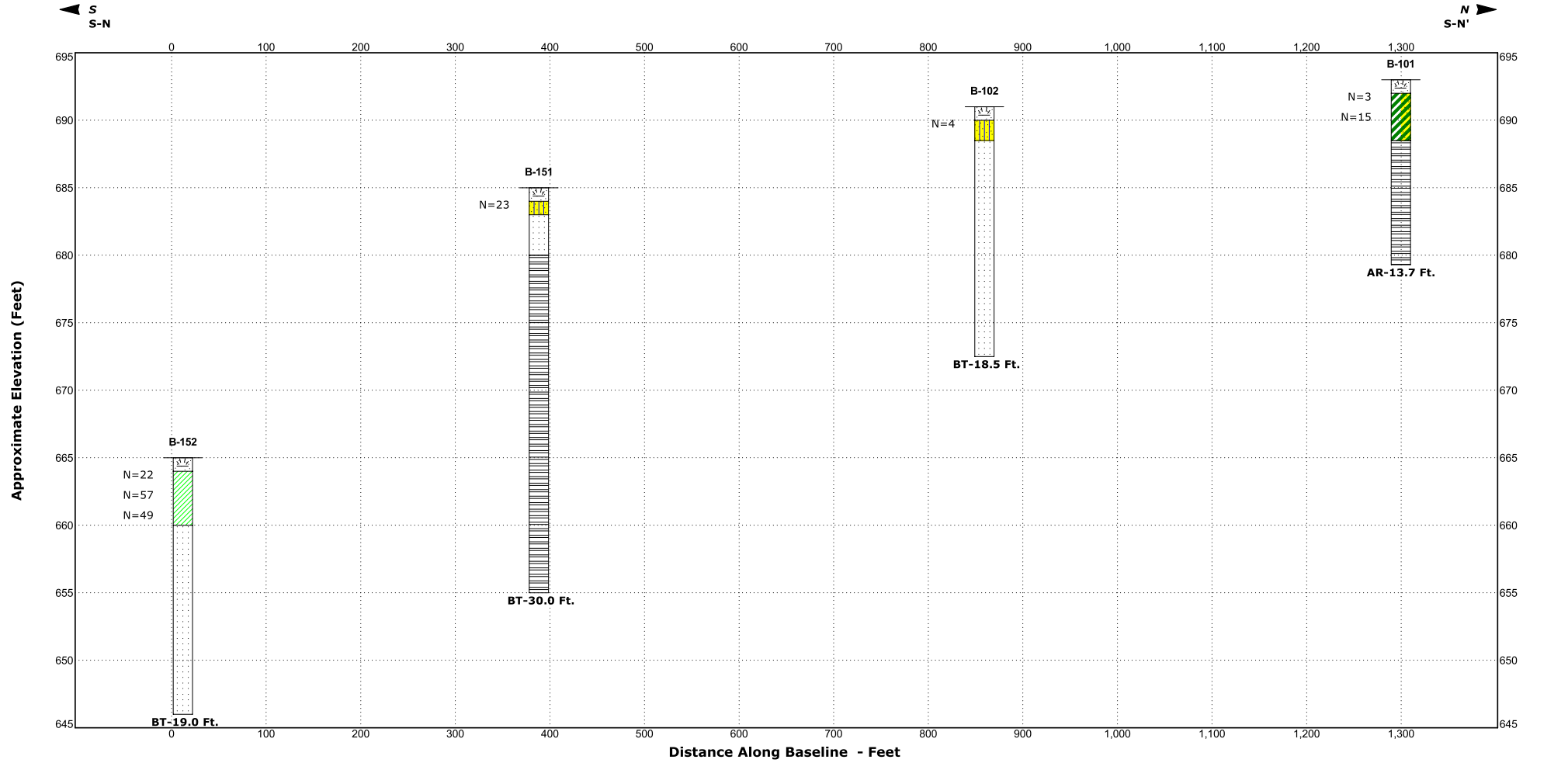
Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-228 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Lean Clay with Sand; Shale; Sandstone

Clydesdale Design Level Geotech
E 76th Street N | Owasso, OK
Terracon Project No. 04255087

Subsurface Profile

Phase 3 Spine Road

9522 E 47th Pl, Ste D
Tulsa, OK



Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	B-101 — Borehole Number Moisture Content — %w LL PL — Liquid and Plastic Limits Sampling (See General Notes) — Borehole Lithology AR / BT — Borehole Termination Type	Topsoil; Fat Clay with Sand; Shale; Silty Sand; Sandstone; Lean Clay

Rock Core Photography Logs

Rock Core Photography Log

B-103; 10-20 ft

B-103; 20-30 ft

B-103; 25-30 ft

B-105; 10-20 ft

B-105; 20-30 ft

B-106; 10-20 ft

B-107; 10-20 ft

B-108A; 10-20 ft

B-108A; 19-30 ft

B-109; 10-20 ft

B-109; 20-30 ft

B-125A; 10-20 ft

B-126; 10-20 ft

B-126; 20-30 ft

B-131; 20-30 ft

B-137; 10-20 ft

B-141; 25-30 ft

B-148; 10-20 ft

B-151; 10-20 ft

B-151; 20-30 ft

B-152; 20-30 ft

B-156; 10-20 ft

B-156; 20-30 ft

B-157; 10-20 ft

B-157; 30-40 ft

B-158; 10-20 ft

B-158; 20-30 ft

B-165; 10-20 ft

B-165; 20-30 ft

B-166; 15-25 ft

B-166; 25-35 ft

B-167; 10-20 ft

B-167; 20-30 ft

B-170; 10-20 ft

B-176; 15-25 ft

B-176; 25-35 ft

B-176; 35-40 ft

B-181; 10-20 ft

B-181; 15-25 ft

B-181; 25-30 ft

B-186; 14-24 ft

B-187; 14-24 ft

B-191; 15-25 ft

B-195; 20-30 ft

B-197; 10-20 ft

B-197; 20-30 ft

B-199; 20-30 ft

B-203; 15-25 ft

B-207; 20-30 ft

Supporting Information

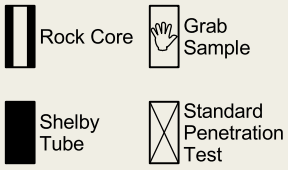
Contents:

General Notes
Unified Soil Classification System
Rock Classification Notes

Note: All attachments are one page unless noted above.

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

General Notes

Sampling	Water Level	Field Tests
	Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	N Standard Penetration Test Resistance (Blows/Ft.) (HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer UC Unconfined Compressive Strength (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils
(More than 50% retained on No. 200 sieve.)
Density determined by Standard Penetration Resistance

Relative Density	Standard Penetration or N-Value (Blows/Ft.)
Very Loose	0 - 3
Loose	4 - 9
Medium Dense	10 - 29
Dense	30 - 50
Very Dense	> 50

Consistency of Fine-Grained Soils
(50% or more passing the No. 200 sieve.)
Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance

Consistency	Unconfined Compressive Strength Qu (psi)	Standard Penetration or N-Value (Blows/Ft.)
Very Soft	less than 3.50	0 - 1
Soft	3.5 to 7.0	2 - 4
Medium Stiff	7.0 to 14.0	5 - 8
Stiff	14.0 to 28.0	9 - 15
Very Stiff	28.0 to 55.5	16 - 30
Hard	> 55.5	> 30

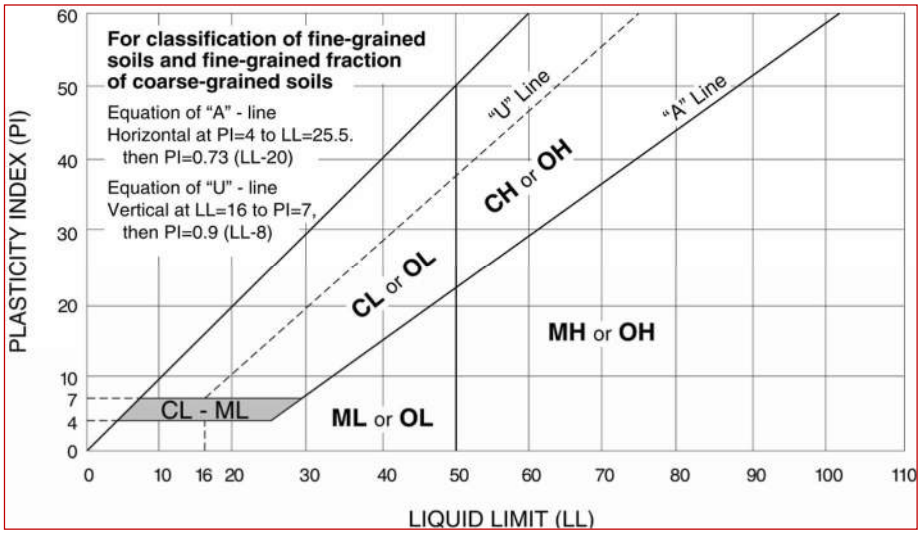
Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.



Rock Classification Notes

WEATHERING	
Term	**Description**
Fresh	Mineral crystals appear bright; show no discoloration. Features show little or now staining on surfaces. Discoloration does not extend into intact rock.
Slightly weathered	Rock generally fresh except along fractures. Some fractures stained and discoloration may extend <0.5 inches into rock.
Moderately weathered	Significant portions of rock are dull and discolored. Rock may be significantly weaker than in fresh state near fractures. Soil zones of limited extent may occur along some fractures.
Highly weathered	Rock dull and discolored throughout. Majority of rock mass is significantly weaker and has decomposed and/or disintegrated; isolated zones of stronger rock and/or soil may occur throughout.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The rock mass or fabric is still evident and largely intact. Isolated zones of stronger rock may occur locally.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, psi**
Extremely strong	Can only be chipped with geological hammer. Rock rings on hammer blows. Cannot be scratched with a sharp pick. Hand specimens require several hard hammer blows to break.	>36,000
Very strong	Several blows of a geological hammer to fracture. Cannot be scratched with a 20d common steel nail. Can be scratched with a geologist's pick only with difficulty.	15,000-36,000
Strong	More than one blow of a geological hammer needed to fracture. Can be scratched with a 20d nail or geologist's pick. Gouges or grooves to ¼ inch deep can be excavated by a hard blow of a geologist's pick. Hand specimens can be detached by a moderate blow.	7,500-15,000
Medium strong	One blow of geological hammer needed to fracture. Can be distinctly scratched with 20d nail. Can be grooved or gouged 1/16 in. deep by firm pressure with a geologist's pick point. Can be fractured with single firm blow of geological hammer. Can be excavated in small chips (about 1-in. maximum size) by hard blows of the point of a geologist's pick;	3,500-7,500
Weak	Shallow indent by firm blow with geological hammer point. Can be gouged or grooved readily with geologist's pick point. Can be excavated in pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.	700-3,500
Very weak	Crumbles under firm blow with geological hammer point. Can be excavated readily with the point of a geologist's pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.	150-700

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Intensely fractured	< 2.5 inches	**Laminated**	< ½-inch
Highly fractured	2.5 – 8 inches	**Very thin**	½ – 2 inches
Moderately fractured	8 inches to 2 feet	**Thin**	2 inches – 1 foot
Slightly fractured	2 to 6.5 feet	**Medium**	1 – 3 feet
Very slightly fractured	> 6.5 feet	**Thick**	3 – 10 feet
		Massive	> 10 feet

ROCK QUALITY DESIGNATION (RQD) [1]	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Phased construction.
4. Contractor's use of site and premises.
5. Coordination with occupants.
6. Work restrictions.
7. Specification and Drawing conventions.
8. Permit requirements.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary utilities, support facilities, and security and protection facilities.
2. Section 016400 "Owner-Furnished Products" for coordination of Owner-furnished products.

1.3 PROJECT INFORMATION

A. Project Identification: Clydesdale HUB1 1-3

1. Project Location: Owasso, Oklahoma.

B. Owner: Confidential Client.

1. Owner's Representative: To be determined.

C. Architect: DLR Group.

1. Architect's Representative: Scott Shiffermiller, sshiffermiller@dlrgroup.com.

D. Civil/Landscape Consultant: Kimley Horn.

1. Civil/Landscape Representative: Brent Massey, brent.masey@kimley-horn.com.

E. Contractor: To be determined.

1. Contractor Representative: To be determined.

F. Web-Based Project Software: Project software will be used for purposes of managing communication and documents during the construction stage.

1. See Section 013100 "Project Management and Coordination." for requirements for using web-based Project software.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:

1. Single story office building constructed in either a single phase or any variation of three total phases. The primary use of the building will be open office space, conference rooms, a café, and other Work supporting the primary functions as indicated in the Contract Documents.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.5 PHASED CONSTRUCTION

A. Construct the Work in phases, with each phase constructed under a separate Contract and as indicated on Drawings.

B. Before commencing Work of each phase, submit an updated copy of Contractor's construction schedule, showing the sequence, commencement, and completion dates for subsequent phases of the Work.

1.6 CONTRACTOR'S USE OF SITE AND PREMISES

A. Unrestricted Use of Site: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.

1.7 COORDINATION WITH OCCUPANTS

A. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.

1. Contractor will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.8 WORK RESTRICTIONS

A. Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.

B. Smoking and Controlled Substance Restrictions: Use of tobacco products, alcoholic beverages, and other controlled substances on Owner's property is not permitted.

C. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.

D. Employee Screening: Comply with Owner's requirements for background screening of Contractor personnel working on Project site.

1. Maintain list of approved screened personnel with Owner's representative.

1.9 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.

C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings and published as part of the U.S. National CAD Standard.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.10 PERMIT REQUIREMENTS

A. Permits necessary for the execution of the Work shall be secured and paid for by the Architect unless otherwise directed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include, as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation, whether or not indicated as part of alternate.

B. Execute accepted alternates under the same conditions as other Work of the Contract.

C. Schedule: A Part 3 "Schedule of Alternates" Article is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Not Used.

END OF SECTION 012300

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:

1.
2. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required to meet other Project requirements but may offer advantage to Contractor or Owner such as value engineering.

B. Value Engineering: Changes to affect economy in the cost of constructing a project and evaluating and bettering of materials and systems in terms of dollars and functional objectives.

1.4 ACTION SUBMITTALS

A. Substitution Requests: Submit documentation identifying product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use form that is part of web-based Project management software.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication, or installation method cannot be provided, if applicable.
b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.7 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Architect and Owner’s Representative will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

    a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    b. Requested substitution provides sustainable design characteristics that specified product provided for compliance with sustainability requirements.
    c. Substitution request is fully documented and properly submitted.
    d. Requested substitution will not adversely affect Contractor's construction schedule.
    e. Requested substitution has received necessary approvals of authorities having jurisdiction.
    f. Requested substitution is compatible with other portions of the Work.
    g. Requested substitution has been coordinated with other portions of the Work.
    h. Requested substitution provides specified warranty.
    i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience and Value Engineering: Architect and Owner’s Representative will consider requests for substitution if received within 60 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Architect and Owner’s Representative.

1. Conditions: Architect and Owner’s Representative will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
b. Requested substitution does not require extensive revisions to the Contract Documents.
c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
d. Requested substitution provides sustainable design characteristics that specified product provided for compliance with sustainability requirements.
e. Substitution request is fully documented and properly submitted.
f. Requested substitution will not adversely affect Contractor's construction schedule.
g. Requested substitution has received necessary approvals of authorities having jurisdiction.
h. Requested substitution is compatible with other portions of the Work.
i. Requested substitution has been coordinated with other portions of the Work.
j. Requested substitution provides specified warranty.
k. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

POST-BID REQUEST FOR SUBSTITUTION FORM

To: DLR Group inc., a Washington corporation
51 University Street, Suite 600
Seattle, WA 98101

PROJECT: _____

CONTRACTOR'S REQUEST, WITH SUPPORTING DATA

1. Reason for Substitution Request: _____

_____

2. Specifications to which this request applies: _____ _____ _____
Section *Page* *Paragraph*

☐ Product Data for proposed substitution is attached (description of product, reference standards, performance and test data).

☐ Sample is attached. ☐ Sample will be sent if requested by Architect/Engineer.

3. Itemized comparison of proposed substitution with product specified:

	ORIGINAL PRODUCT	PROPOSED SUBSTITUTION
Name, brand:		
Catalog No.:		
Manufacturer:		
Significant Variations:		

4. Unit costs of original product and proposed substitution. State whether cost is for

☐ material only, ☐ material installed, or ☐ Life Cycle cost of installed product.

Original Product: $_____ per _____ Substitution: $_____ per _____

5. Proposed change in Contract Sum:
Credit to Owner: $_____ Additional Cost to Owner: $ _____

6. Proposed Change in Contract Time: ☐ Reduce ☐ Increase by _____ days.

7. Effect of proposed substitution on other parts of the Work, or on other Contracts:

_____
_____
_____
_____

CONTRACTOR'S STATEMENT
OF CONFORMANCE
OF PROPOSED SUBSTITUTION TO CONTRACT DOCUMENTS

I/we have investigated the proposed substitution. I/we:

1. believe that it is equal or superior in all respects to the originally specified product, except as stated in 3. above;
2. will provide the same warranty as required in AIA A201 General Conditions 3.5.1;
3. will provide the same special warranty or guaranty as specified;
4. have included all cost data and cost implications of the proposed substitution;
5. will pay redesign and special inspection costs caused by the use of this product;
6. will pay additional costs to other contractors caused by the substitution;
7. will coordinate the incorporation of the proposed substitution in the Work;
8. will modify other parts of the Work as may be needed, to make all parts of the Work complete and functioning;
9. waive future claims for added cost to Contractor caused by the proposed substitution.

Contractor: _____ Date: _____
(Signature)

Firm: _____

ARCHITECT/ENGINEER'S REVIEW AND ACTION

☐ Provide more information in the following categories. Resubmit.

_____

_____

☐ Sign Contractor's Statement of Conformance. Resubmit.

☐ The proposed substitution is approved, with the following conditions:

_____

_____

☐ The proposed substitution is rejected, use specified materials:

_____

_____

The following changes will be made by Change Order:

Addition to / deduction from the Contract Sum: $_____

Addition to / deduction from the Contract Time: _____ days.

DLR Group inc.

By _____ Date: _____
(Signature)

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Requirements:

1. Section 012500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.
2. Section 013100 "Project Management and Coordination" for requirements for forms for contract modifications provided as part of web-based Project management software.

1.3 MINOR CHANGES IN THE WORK

A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on web-based Project management software.

1.4 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
c. Include costs of labor and supervision directly attributable to the change.

d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
e. Quotation Form: Use form provided as part of web-based Project management software.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use form provided as part of web-based Project management software.

1.5 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Work Change Proposal Request, Contractor will issue a Change Order for signatures of Owner and Contractor on form provided as part of web-based Project management software.

1.6 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Architect may issue a Construction Change Directive on form provided as part of web-based Project management software. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:

1. General coordination procedures.
2. Coordination drawings.
3. RFIs.
4. Digital project management procedures.
5. Web-based Project management software package.
6. Project meetings.

B. Related Requirements:

1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
4. Section 017839 "Project Record Documents" for administrative and procedural requirements for Project Record Documents.
5. Section 019113 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.3 DEFINITIONS

A. BIM: Building Information Modeling.

B. RFI: Request for Information. Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Within fifteen (15) days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, cellular telephone numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, in web-based Project software directory, and in prominent location in each built facility. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and scheduled activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

    a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
    b. Coordinate the addition of trade-specific information to coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
    c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
    e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
    f. Indicate required installation sequences.
    g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms, showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.

6. Mechanical and Plumbing Work: Show the following:

    a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts, and electrical distribution equipment.
    c. Fire-rated enclosures around ductwork.

7. Electrical Work: Show the following:

    a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.
    b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
    c. Panel board, switchboard, switchgear, transformer, busway, generator, and motor-control center locations.
    d. Location of pull boxes and junction boxes, dimensioned from column center lines.

8. Fire-Protection System: Show the following:

    a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

9. Review: Architect will review coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.
10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."

C. Coordination Drawing Process: Prepare coordination drawings in the following manner:

1. Schedule submittal and review of Fire Sprinkler, Plumbing, HVAC, and Electrical Shop Drawings to make required changes prior to preparation of coordination drawings.
2. Commence routing of coordination drawing files with HVAC Installer, who will provide drawing plan files denoting approved ductwork. HVAC Installer will locate ductwork and piping on a single layer, using orange color. Forward drawings to Plumbing Installer.
3. Plumbing Installer will locate plumbing and equipment on a single layer, using blue color.
4. Fire Sprinkler Installer will locate piping and equipment, using red color. Fire Sprinkler Installer shall forward drawing files to Electrical Installer.
5. Electrical Installer will indicate service and feeder conduit runs and equipment in green color. Electrical Installer shall forward drawing files to Communications and Electronic Safety and Security Installer.
6. Communications and Electronic Safety and Security Installer will indicate cable trays and cabling runs and equipment in purple color. Communications and Electronic Safety and Security Installer shall forward completed drawing files to Contractor.
7. Contractor shall perform the final coordination review. As each coordination drawing is completed, Contractor will meet with Architect to review and resolve conflicts on the coordination drawings.

D. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format:

a. Same digital data software program, version, and operating system as original Drawings.

2. File Submittal Format: Submit or post coordination drawing files using PDF format.
3. BIM File Incorporation: Develop and incorporate coordination drawing files into BIM established for Project.

a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.

4. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.

a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
b. Digital Data Software Program: Drawings are available in Revit 2022.
c. Contractor shall execute a data licensing agreement in the form of AIA Document C106.

1.7 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Owner name.
3. Owner's Project number.
4. Name of Architect.
5. Architect's Project number.
6. Date.
7. Name of Contractor.
8. RFI number, numbered sequentially.
9. RFI subject.

10. Specification Section number and title and related paragraphs, as appropriate.
11. Drawing number and detail references, as appropriate.
12. Field dimensions and conditions, as appropriate.
13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
14. Contractor's signature.
15. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.

1. BIM 360 Project Management module shall be used for the submission, tracking, and approval of all project RFIs and Submittals.
2. The Owner will make the module available as part of the overall BIM 360 Owner-controlled suite.
3. The Owner will provide training on an as-needed basis.

D. Architect's Action: Architect will review each RFI, determine action required, and respond.

1. Allow seven (7) business days for Architect's response for each RFI.
2. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
3. The following Contractor-generated RFIs will be returned without action:

    a. Requests for approval of submittals.
    b. Requests for approval of substitutions.
    c. Requests for approval of Contractor's means and methods.
    d. Requests for coordination information already indicated in the Contract Documents.
    e. Requests for adjustments in the Contract Time or the Contract Sum.
    f. Requests for interpretation of Architect's actions on submittals.
    g. Incomplete RFIs or inaccurately prepared RFIs.

4. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
5. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."

    a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use software log that is part of web-based Project management software. Include the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Architect.
4. RFI number, including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date Architect's response was received.
8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.

1.8 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Use of Architect's Digital Data Files: Digital data files of Architect's BIM model will be provided by Architect for Contractor's use during construction.

1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
3. Digital Drawing Software Program: Contract Drawings are available in BIM 360 Contract Documents.
4. Contractor shall execute a data licensing agreement in the form of AIA Document C106 Digital Data Licensing Agreement.

    a. Subcontractors and other parties granted access by Contractor to Architect's digital data files shall execute a data licensing agreement in the form of AIA Document C106.

B. Web-Based Project Management Software Package: Use Owner's web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion.

1. Web-based Project management software includes, at a minimum, the following features:

    a. Compilation of Project data, including Contractor, subcontractors, Architect, Architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
    b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
    c. Document workflow planning, allowing customization of workflow between project entities.

d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
e. Track status of each Project communication in real time, and log time and date when responses are provided.
f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
g. Processing and tracking of payment applications.
h. Processing and tracking of contract modifications.
i. Creating and distributing meeting minutes.
j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
k. Management of construction progress photographs.
l. Mobile device compatibility, including smartphones and tablets.

2. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.

C. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:

1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.9 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times a minimum of seven days prior to meeting.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.

1. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the

conference shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Discuss items of significance that could affect progress, including the following:

    a. Responsibilities and personnel assignments.
    b. Tentative construction schedule.
    c. Phasing.
    d. Critical work sequencing and long lead items.
    e. Designation of key personnel and their duties.
    f. Lines of communications.
    g. Use of web-based Project software.
    h. Procedures for processing field decisions and Change Orders.
    i. Procedures for RFIs.
    j. Procedures for testing and inspecting.
    k. Procedures for processing Applications for Payment.
    l. Distribution of the Contract Documents.
    m. Submittal procedures.
    n. Sustainable design requirements.
    o. Preparation of Record Documents.
    p. Use of the premises.
    q. Work restrictions.
    r. Working hours.
    s. Owner's occupancy requirements.
    t. Responsibility for temporary facilities and controls.
    u. Procedures for moisture and mold control.
    v. Procedures for disruptions and shutdowns.
    w. Construction waste management and recycling.
    x. Parking availability.
    y. Office, work, and storage areas.
    z. Equipment deliveries and priorities.
    aa. First aid.
    bb. Security.
    cc. Progress cleaning.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other Sections and when required for coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect, and Owner's Commissioning Authority of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

    a. Contract Documents.
    b. Options.

c. Related RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Sustainable design requirements.
i. Review of mockups.
j. Possible conflicts.
k. Compatibility requirements.
l. Time schedules.
m. Weather limitations.
n. Manufacturer's written instructions.
o. Warranty requirements.
p. Compatibility of materials.
q. Acceptability of substrates.
r. Temporary facilities and controls.
s. Space and access limitations.
t. Regulations of authorities having jurisdiction.
u. Testing and inspecting requirements.
v. Installation procedures.
w. Coordination with other work.
x. Required performance results.
y. Protection of adjacent work.
z. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

a. Preparation of Record Documents.
b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.

c. Procedures for completing and archiving web-based Project software site data files.
d. Submittal of written warranties.
e. Requirements for completing sustainable design documentation.
f. Requirements for preparing operations and maintenance data.
g. Requirements for delivery of material samples, attic stock, and spare parts.
h. Requirements for demonstration and training.
i. Preparation of Contractor's punch list.
j. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
k. Submittal procedures.
l. Coordination of separate contracts.
m. Owner's partial occupancy requirements.
n. Installation of Owner's furniture, fixtures, and equipment.
o. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Conduct progress meetings at weekly intervals.

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

1) Review schedule for next period.

b. Review present and future needs of each entity present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Resolution of BIM component conflicts.
4) Status of submittals.
5) Status of sustainable design documentation.
6) Deliveries.
7) Off-site fabrication.
8) Access.
9) Site use.

10) Temporary facilities and controls.
11) Progress cleaning.
12) Quality and work standards.
13) Status of correction of deficient items.
14) Field observations.
15) Status of RFIs.
16) Status of Proposal Requests.
17) Pending changes.
18) Status of Change Orders.
19) Pending claims and disputes.
20) Documentation of information for payment requests.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

F. Coordination Meetings: Conduct Project coordination meetings at weekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.

1. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
c. Review present and future needs of each contractor present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Resolution of BIM component conflicts.
4) Status of submittals.
5) Deliveries.

6) Off-site fabrication.
7) Access.
8) Site use.
9) Temporary facilities and controls.
10) Work hours.
11) Hazards and risks.
12) Progress cleaning.
13) Quality and work standards.
14) Status of RFIs.
15) Proposal Requests.
16) Change Orders.
17) Pending changes.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Daily construction reports.
2. Material location reports.
3. Site condition reports.

B. Related Requirements:

1. Section 013523.1 "Construction Incident Notification" for construction incident notifications and unusual event reporting.
2. Section 014000 "Quality Requirements" for schedule of tests and inspections.
3. Contract Documents for Contractor’s Construction Schedule requirements.

1.3 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. PDF file.

B. Daily Construction Reports: Submit at weekly intervals.

C. Material Location Reports: Submit at weekly intervals.

D. Site Condition Reports: Submit at time of discovery of differing conditions.

1.4 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.

4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Testing and inspection.
8. Accidents.
9. Meetings and significant decisions.
10. Unusual events.
11. Stoppages, delays, shortages, and losses.
12. Meter readings and similar recordings.
13. Emergency procedures.
14. Orders and requests of authorities having jurisdiction.
15. Change Orders received and implemented.
16. Construction Change Directives received and implemented.
17. Services connected and disconnected.
18. Equipment or system tests and startups.
19. Partial completions and occupancies.
20. Substantial Completions authorized.

B. Material Location Reports: At weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:

1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200

SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Preconstruction photographs.
2. Concealed Work photographs.
3. Periodic construction photographs.
4. Final Completion construction photographs.
5. Construction webcam.

B. Related Requirements:

1. Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
2. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
3. Section 013233.11 "DCDE Construction Photo Policy" for Owner’s policy regulating the capture and distribution of images of buildings and sites under active construction.

1.3 INFORMATIONAL SUBMITTALS

A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph and video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

B. Digital Photographs: Submit image files within three days of taking photographs.

1. Submit photos by uploading to web-based Project management software site. Include copy of key plan indicating each photograph's location and direction.
2. Identification: Provide the following information with each image description in web-based Project management software site:

a. Name of Project.
b. Name and contact information for photographer.
c. Name of Architect.
d. Name of Contractor.

e. Date photograph was taken.
f. Description of location, vantage point, and direction.
g. Unique sequential identifier keyed to accompanying key plan.

1.4 QUALITY ASSURANCE

A. Construction Webcam Service Provider: A firm specializing in providing photographic equipment, web-based software, and related services for construction projects, with a record of providing satisfactory services similar to those required for Project.

1.5 FORMATS AND MEDIA

A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit conditions.

B. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

C. Metadata: Record accurate date and time from camera.

D. File Names: Name media files with date and sequential numbering suffix.

1.6 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs with maximum depth of field and in focus.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.

B. Preconstruction Photographs: Before commencement of the Work, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.

1. Flag construction limits before taking construction photographs.
2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
3. Take 20 photographs of existing buildings either on or adjoining property, to accurately record physical conditions at start of construction.
4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

C. Concealed Work Photographs: Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed Work, including, but not limited to, the following:

1. Underground utilities.
2. Underslab services.
3. Piping.
4. Electrical conduit.
5. Waterproofing and weather-resistant barriers.

D. Periodic Construction Photographs: Take 20 photographs weekly. Select vantage points to show status of construction and progress since last photographs were taken.

E. Final Completion Construction Photographs: Take 50 photographs after date of Substantial Completion for submission as Project Record Documents. Architect will inform photographer of desired vantage points.

1.7 CONSTRUCTION WEBCAM

A. Webcam: Provide fixed-location camera with weatherproof housing, mounted to provide unobstructed view of construction site from location approved by Architect, with the following characteristics:

1. Remotely controllable view with mouse-click user navigation for horizontal pan, vertical tile, and optical zoom of 500 percent minimum.
2. Capable of producing minimum 12-megapixel images.
3. Provide power supply, active high-speed data connection to service provider's network, and static public IP address for each camera.

B. Web-Based Interface: Provide online interface to allow viewing of each high-definition digital still image captured and stored during construction, from the Internet.

1. Access Control: Provide password-protected access for Project team administered by Contractor, providing current image access and archival image access by date and time, with images downloadable to viewer's device.
2. Storage: Maintain images on the website for reference during entire construction period, and for not less than 30 days after Final Completion. Provide sufficient memory on remote server to store all Project images.
3. Online Interface: Provide website interface with Project and client information and logos, calendar-based navigation interface for selecting images, and pan and zoom capability within high-definition images.
4. Forward and Reverse: Provide capability to browse through images, moving forward and backward in time by individual image and by day.
5. Slideshow: Provide capability to automatically display current images from sites when there are three or more cameras used.
6. Time-Lapse: Provide capability for online display of project time-lapse.
7. Dashboard: Provide capability to view thumbnails of all cameras on one screen.
8. Weather: Provide corresponding weather data for each image captured.

C. Maintain cameras and web-based access in good working order, according to web-based construction photographic documentation service provider's written instructions until Final Completion. Provide for service of cameras and related networking devices and software.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013233

SECTION 013233.11
DCDE CONSTRUCTION PHOTO POLICY

TABLE OF CONTENTS

PROJECT-SPECIFIC AMENDMENTS

GENERAL
- SUMMARY
- DEVICE SCOPE
- CONSTRUCTION PHOTO POLICY
- UNMANNED AERIAL VEHICLES AND DRONE PHOTOGRAPHY
- CONSTRUCTION PHOTO PASSES AND PROCESSES
- POLICY EXCEPTIONS
- VIOLATIONS AND CONSEQUENCES
- TRANSITION FROM CONSTRUCTION TO OPERATIONAL POLICY
- EXHIBIT 1 - PHOTO PASS TEMPLATES

PRODUCTS (NOT USED)

EXECUTION (NOT USED)

PART 1 - GENERAL

1.1 SUMMARY

A. The intent of this document is to regulate the capture and distribution of images at Owner data centers and construction sites. This policy applies to buildings and sites under active construction and is managed and enforced by DCPMG and DCDE. This policy is in effect as soon as our contractors mobilize to the site, secure it, and start work.

B. The photo policy for operational data centers is separate from this policy and is managed and enforced by CSRM in accordance with the Data Center Photo Policy. Retro-fit, refresh, and refactor projects within operational data centers **must** adhere to the Data Center Photo Policy.

C. The keywords "**must**", "**must not**", "**required**", "**shall**", "**shall not**", "**should**", "**should not**", "**recommended**", "**may**", and "**optional**" in this document are to be interpreted as described in RFC 2119 (https://tools.ietf.org/html/rfc2119).

D. Any Owner Employee[1] , TVC (Temporary worker, Vendor, Contractor/Sub-Contractor), or any individual who works in, or visits an Owner data center construction site must read this policy.

E. Related Requirements:

1. SECTION 013233 - Photographic Documentation

1.2 DEVICE SCOPE

Individuals working on the site **shall** only capture images using approved cameras.

F. Digital still cameras that are non-Internet capable (that is, not connected to Wi-Fi or cellular data) are permitted.

G. Digital imaging devices such as Google Glass or Holographic AR/VR glasses may be permitted, only after demonstrating that the videos/images captured from these devices are transmitted securely to authorized users with appropriate access control (password) in place. These devices must be pre-approved before using at site.

H. Time-lapse cameras, when installed, should have appropriate access control and data-retention methodologies in place, where the access to live view or recording is not exposed to unauthorized personnel. Position of time-lapse cameras should be such that it does not cover any owner sensitive equipment and/or doesn't conflict with photography policy of any operational sites in vicinity, if any.

I. Personnel **shall not** capture images using mobile devices with built-in cameras, such as smartphones, tablets, digital media players, e-readers, and so on, unless using an approved construction management software or going through the Field Integration and Assembling (FIA) solution, Production Planning Tool (PPT), on a vendor issued device with a corporate device policy installed using an Owner partner domain account **or** a device with Owner Device Policy installed using a Gsuite or *@owner* account.

1.3 CONSTRUCTION PHOTO POLICY

J. Those taking photos at construction sites require an approved photo pass or the CSRM Photo App and **must** follow the processes defined in this document.

K. Personnel **must not** take photographs at construction sites, unless doing so is directly related to their job function and they have been authorized.

L. Images of Owner sensitive equipment **must not** be captured. This includes any IT equipment

[1] Owner Employee with active “all sites” or site/campus Operational photo passes are exempt from the construction photo and device pass requirements.

such as servers, storage devices, network switches, routers, and so on.

1. If your Owner job function requires images that include sensitive equipment, explicit written permission from an Owner operations manager is required.
2. If you are unsure if photos meet the above requirements, do not approve; escalate to the Owner point of contact.

M. Images **should** be related only to safety, construction activities, progress, or issues.

N. Violation of the policy **may** result in the permanent loss or denial of site access privileges.

Note: Owner employees should read the data center photo policy as a refresher and be cautious when sharing images outside or within the company.

1.4 UNMANNED AERIAL VEHICLES AND DRONE PHOTOGRAPHY

Flying unauthorized Unmanned Aerial Vehicles (UAV) is prohibited at Owner construction sites. Authorized UAV flights are subject to the following conditions:

O. Drones equipped with cameras **may** be used to capture footage, but require both an operator photo pass and a device photo pass (calling out the specific drone or camera).

P. The operator **must** carry both approved passes while capturing footage on site.

Q. The construction security team **must** be notified prior to flying the drone each time. Notification will prevent erroneous incident reports or the need to search for the operator.

1.5 CONSTRUCTION PHOTO PASSES AND PROCESSES

R. Individual photo pass

1. Each individual **must** complete the photo pass authorization form.
2. The form **must** be approved by the DCDE PM or GSM/RSM, and the photo pass **must** be issued before any images are captured. (See site security manager for site contacts.)
3. The approved photo pass form will be submitted to the construction site security manager[2] who will issue the pass and maintain a log of photo passes issued. Photo passes can be picked up at the construction security kiosk during business hours.
4. The user **must** display the photo pass at all times while on site.
5. These passes **shall** be easily distinguishable from other photo passes that may be in use on site.

Note: All visitors approved for a photo pass **must** wear a special-colored safety vest or lanyard (issued by security) upon entering the site. The photo pass and vest **must** be visible at all times.

S. Device photo pass

1. For each device to be used to capture images, the device photo pass authorization form **must** be completed.
2. The form **must** be approved by the DCDE PM, and the photo pass issued, before any images are captured on the device.
3. Submit the approved device photo pass form to the construction site security manager who will issue the pass and maintain a log of passes issued. Device passes can be picked up at the construction security kiosk during normal business hours.
4. All devices used to capture images **must** have a device photo pass displayed on the

[2] *Construction site security will be provided by Owner Security, or by the General Contractor (GC) through their vendor. The party responsible for construction site security will manage and enforce this policy.*

device at all times. These passes shall be easily distinguishable from other device passes that may be in use on site.

5. Approved devices **must** be kept in a secure location and will be issued to approved individuals as needed by the responsible vendor.
6. Devices **shall not** leave the construction site and photos must be deleted on a daily basis.

Note: Owner employees are permitted to submit photo and device pass forms using email (attached in Docs format) in advance of their visit to the construction site. Email approvals are acceptable and signatures are not required.

T. Authorization for sharing of captured images
Owner employees and certain key business partners (TVCs) **shall** be allowed to capture images without DCDE PM review, but only after completing the camera authorization form and receiving approval.

1. A valid business reason or project description must accompany all requests.
2. Images captured on a digital still camera and shared through Google Drive **must** abide by the following:
   a. All images captured anywhere on site **must** be uploaded directly from the camera (or card) to the specified Google Drive folder for that project, and then subsequently erased from the camera (or card).
   b. Access to the Google Drive folders will be granted by the DCDE PM who can provide upload instructions if required.
3. Images captured and shared through the Production Planning Tool process **must** abide by the following:
   a. All images captured through a non-still digital camera must be a vendor issued device with a corporate device policy installed using an Owner Partner Domain account **or** a device with Owner Device Policy installed using a Gsuite or *@owner* account.
   b. The DCDE PM **must** review all images captured on a mobile smartphone prior to having the images uploaded from the local device to the Production Planning Tool (PPT).
   c. The DCDE PM **must** confirm the deletion of the photos from the local device after the photos are uploaded to the PPT.
4. These photos **may** be used for distribution to Owner Employees (*@owner* accounts) having a specific business need.
5. If the photos need to be shared with external business partners the DCDE PM **must** review these photos before they are shared.

U. CSRM Photo App
Owner employees and certain key business partners (TVCs) shall be allowed to capture images with the CSRM photo app and are required to follow this process:

1. The corporate mobile device policy must be respected when using the app.
2. The app can be accessed on your phone at http://goto.google.com/gdcphotoapp. (You must be logged into Chrome with your @google.com account.)
3. After submission, DCDE management reviews, approves, and shares photos with the requestor.
4. For a tutorial on app usage, visit the CSRM Photo App Manual.

1.6 POLICY EXCEPTIONS

V. General

1. Many construction sites utilize construction management software (for example, Exitus, Latista, Bim360, CxAlloy, and so on) to document the quality control (QC) process. Contractors and Owner employees who have an approved photo pass and an approved device (vendor issued device with a corporate device policy installed using a Owner partner domain account **or** a device with Owner Device Policy installed using a Gsuite or *@owner* account), **will** have permission to use the image capture feature of the application on their phone, tablet or notebook PC to document quality control issues in the field with the following conditions:
   a. Photos **shall** be close up and issue-specific, and must contain only the details required to illustrate the quality control report. (General "zoomed out" photos of equipment skids, building spaces, and other equipment is not permitted.)
   b. Photos **shall** be attached to the QC report and are to be distributed only to the subcontractor or vendor affected by the report.
   c. Photos are to be permanently deleted from the approved device following upload to the secure database.
   d. If the photos will be uploaded to the FIA PPT, the following additional conditions **must** be met:
      1) The DCDE PM **must** confirm that the user with the photo pass has an Owner Device Policy installed with an *@owner* account or Owner partner domain.
      2) The DCDE PM **must** review all images captured on a mobile smartphone prior to having the images uploaded from the local device to the PPT.
      3) The DCDE PM **must** confirm the deletion of the photos from the local device after the photos are uploaded to the PPT.
   e. BIM360 can be utilized to finalize YAWN close-out activities between FR and FHO and during Marcus Construction and close-out under the following conditions:
      1) All requests for usage of the BIM360 tool are to be filed through GUTS go/dccamerarequest
      2) Ticket must contain the following data in the request:
         a) Site name
         b) Project name (GBL4, WTP2, and so on)
         c) Start and end date for the use of the BIM360 tool
         d) Area/building of the project
         e) Reason to use the BIM360 tool (proof for snag X, quality, and so on)
      3) Requests must be approved by site management including DCS local or Regional Manager
      4) Dedicated BIM360 photo pass with the approved zone will be provided by security upon verification and will be required to be worn and visible at all times when taking photos. BIM360 photo pass must be returned to security by the end date of the approved ticket.
      5) Use of BIM360 Photos will only be permitted in specific zones during the specific periods on the operational Data Centers that have been requested and approved.

   Note: For the purpose of this policy, the term "contractor" applies to the General Contractor personnel, subcontractors, equipment vendors and commissioning agents, as well as other consultants such as our architects, design engineers, quality inspectors, and so on.
2. Approval is not required before the photo is posted to a QC report and uploaded to the

construction management software, assuming the above conditions are met.

3. Construction Security and EHS personnel may take photos in an emergency (health, fire, life, or safety) situation. These photos shall be approved by DCDE PM prior to release.

W. Infrared cameras

Infrared cameras, laser scan cameras, or other similar devices used for maintenance **may** be used without a camera pass, for maintenance purposes.

X. Authorization to capture video

A valid business reason and a detailed explanation including the areas to be filmed **must** be included with the photo pass authorization form. This includes Owner employees and vendors.

Y. Off-site or factory filming

All off-site or factory filming of Owner IP will be authorized on a case-by-case basis. Much like capturing any images, a valid business reason and detailed explanation **must** be included with the authorization form. The authorizing party **must** make reasonable accommodations for the transfer and editing of footage to maintain the security of the footage at all times. Encrypted hard drives and Google Drive are examples of possible methods.

1.7 VIOLATIONS AND CONSEQUENCES

Owner adheres to a strict guideline for all violators, as the details below provide.

Severity	Violation	Consequence
S1	Photo pass not authorized and taking photos with unauthorized camera devices -or- uploading photos to social media websites	Immediate and permanent dismissal from site, photo policy stand down session for all remaining personnel from the violator's company
S2	Photo pass authorized, taking photos with unauthorized camera devices -or- taking photos in restricted areas, with "no photos" signs	1. Issue final written warning, photo pass temporarily revoked, must attend photo/security training to receive photo pass 2. 2nd violation results in immediate and permanent dismissal from site
S3	Photo pass authorized but is not visible on person -or- not wearing designated photo pass safety vest	1. Issue 1st warning, GC is notified, sign up to attend photo/security training 2. Photo pass temporarily revoked after 2nd warning, GC is notified, must attend photo/security training to receive photo pass 3. Photo pass permanently revoked after 3rd violation

1.8 TRANSITION FROM CONSTRUCTION TO OPERATIONAL POLICY

Z. CCNR

(Includes CCNR equipment rooms, SSNR, POEs, cable vaults)

1. Photo policy enforcement will transition from the DCDE construction policy to the DCOps operational policy at the formal declaration of CCNR-ready by the DCDE PM.
2. This milestone will be communicated to the project team through email.
3. Operational Security in conjunction with DCOps will execute and enforce the operational policy.

AA. DC

(Includes Disk Erase, GTape, MEP equipment rooms, areas, yards, CUB, electrical building)

1. Photo policy enforcement will transition from the DCDE construction policy to the DCOps operational policy at the formal declaration of Facility Ready (FR) by the DCDE PM.
2. This milestone will be communicated to the project team by email.
3. Operational Security, in conjunction with DCOps, will enforce the operational policy.
4. In the case of multi-zone turnovers, secure physical separation between zones will be installed and enforced by Security. If physical separation is not installed, then the entire DC floor will transition to the operational policy.

Note: Construction photo passes may be re-issued prior to FR to further restrict image capture and protect sensitive Owner equipment on the DC floor.

BB. ODC/FSA[3]

Photo policy enforcement will transition from the DCDE construction policy to the DCOps operational policy upon declaring FDOB (first day of business) for the FSA.

CC. Site

(Includes remaining areas, including exterior areas within site perimeter fencing)

1. Site progress cameras (such as time lapse and OxBlue) shall be coordinated and approved by DCDE PM and GSM.
2. Photo policy enforcement will transition from the DCDE construction policy to the DCOps operational policy upon achieving FR for the final zone for the site or project.

1.9 EXHIBIT 1 - PHOTO PASS TEMPLATES

DD. Photo pass criteria

1. Construction site photo passes are to contain the following information (Pass Sample Drawn in Libreoffice available here):
   a. Clear words indicating this is a “CONSTRUCTION CAMERA PASS”
   b. Name of the pass holder
   c. Expiration Date
   d. Site Location
   e. Pass # - To be recorded and tracked
2. Passes shall not contain any wording referring to Owner. Reference to the Vandelay Logo is optional. Color is also optional.

[3] Owner Employees are allowed to use a personal phone/camera to take photos in the Office, Makerspace, Cafe, and Outdoors areas of the data center (including fiber vaults).

Sample Pass

EE. Template information

In order to comply with the program-wide security requirements, a template is being offered to the sites for use in their badge creation software. We would like badges across sites to be consistent in look and feel. Using the template drawn in Open Office and the above sample pass you can create a similar badge for your site by copying and pasting images into your respective badge software.

FF. Device photo passes

To provide consistency across the program we have decided to go with PicStitch as the provider for camera passes. The stickers are numbered, tamper proof, and are to be applied to each device when entering the facility and removed when exiting after images are downloaded.

Device Photo Pass Sample

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

3.1

END OF SECTION

REVISION HISTORY

Version	Date	Description and location of change
1	March 2021	Initial version
2	June 2021	Changed references of “DCID” to “DCDE.”
3	December 2021	Added 1.3:A and 1.3:C: Approval and process for CSRM Photo App usage.
4	February 2022	Added 1.2:B and 1.2:C: Security requirements for digital imaging devices such as Google Glass or Holographic AR/VR glasses and time-lapse cameras.
5	September 2022	Updated Part 0 instructions.

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

B. Related Requirements:

1. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
2. Section 013200 "Construction Progress Documentation" for submitting reports.
3. Section 013233 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and Final Completion construction photographs.
4. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
5. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
6. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
7. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
8. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect’s responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect’s responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.4 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal Schedule: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.

    a. Submit revised submittal schedule as required to reflect changes in current status and timing for submittals.

4. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal Category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Architect's final release or approval.

1.5 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:

1. Project name.
2. Date.
3. Name of Architect.
4. Name of Contractor.
5. Name of firm or entity that prepared submittal.
6. Names of subcontractor, manufacturer, and supplier.
7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
8. Category and type of submittal.
9. Submittal purpose and description.
10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
11. Drawing number and detail references, as appropriate.
12. Indication of full or partial submittal.
13. Location(s) where product is to be installed, as appropriate.
14. Other necessary identification.

15. Remarks.

B. Options: Identify options requiring selection by Architect.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. Submittals Utilizing Web-Based Project Software: Prepare submittals as PDF files or other format indicated by Project management software.

1.6 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow seven (7) business days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow seven (7) days for review of each resubmittal.

4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow twenty-one (21) days for initial review of each submittal.
5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow seven (7) days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.

    a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block, and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect’s action stamp.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

1.7 SUBMITTAL REQUIREMENTS

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.
    e. Testing by recognized testing agency.
    f. Application of testing agency labels and seals.
    g. Notation of coordination requirements.
    h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

    a. Wiring diagrams that show factory-installed wiring.
    b. Printed performance curves.

c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before Shop Drawings, and before or concurrently with Samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Architect's digital data drawing files is otherwise permitted.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. BIM Incorporation: Develop and incorporate Shop Drawing files into BIM established for Project.

C. Samples: Submit Samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.

1. Transmit Samples that contain multiple, related components, such as accessories together in one submittal package.
2. Identification: Permanently attach label on unexposed side of Samples that includes the following:

a. Project name and submittal number.
b. Generic description of Sample.
c. Product name and name of manufacturer.
d. Sample source.
e. Number and title of applicable Specification Section.
f. Specification paragraph number and generic name of each item.

3. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.

b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units, showing the full range of colors, textures, and patterns available.

   a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.

6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

   a. Number of Samples: Submit three sets of Samples. Architect will retain one Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record Sample.

      1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
      2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
2. Manufacturer and product name, and model number if applicable.
3. Number and name of room or space.
4. Location within room or space.

E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

G. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

    a. Name of evaluation organization.
    b. Date of evaluation.
    c. Time period when report is in effect.
    d. Product and manufacturers' names.
    e. Description of product.
    f. Test procedures and results.
    g. Limitations of use.

1.8 DELEGATED DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

C. BIM Incorporation: Incorporate delegated design drawing and data files into BIM established for Project.

1. Prepare delegated design drawings in the following format: Same digital data software program, version, and operating system as original Drawings.

1.9 CONTRACTOR'S REVIEW

A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with indication in web-based Project management software. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.10 ARCHITECT'S REVIEW

A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required.

1. Submittals by Web-Based Project Management Software: Architect will indicate, on Project management software website, the appropriate action.

a. Actions taken by indication on Project management software website have the following meanings:

1) Reviewed: When submittal is marked “Reviewed”, that part of Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
2) Reviewed – Additional Information Required: When submittal is marked “Reviewed – Additional Information Required”, the information submitted has been reviewed and may proceed provided it complies with requirements of the Contract Documents. However, additional information as noted and/or required by Contract Documents needs to be submitted.
3) Furnish as Corrected: When submittal is marked “Furnish As Corrected”, that part of Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend upon that compliance.
4) Revise and Resubmit: When submittal is marked “Revise and Resubmit”, do not proceed with that part of Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat, if necessary, to obtain a different action mark.

a) Do not permit submittals marked “Revise and Resubmit” to be used at the Project site or elsewhere where Work is in progress.

5) Rejected: When submittal is marked “Rejected, information is not incompliance with the Contract Documents. Resubmit submittal as required by Contract Documents.
6) Not Reviewed - Received for Record Purposes Only: Submittals marked “Not Reviewed - Received for Record Purposes Only” means that the Architect is taking possession of submittal information that is not the responsibility of the Project Architect but is submitted as back-up information (calculations, test results, owner-provided information, etc.) to supplement other submittals requirements.

B. Informational Submittals: Architect will review each submittal and will not return it or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Architect will return without review submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300

SECTION 013324
CAD/BIM DOCUMENTATION REQUIREMENTS

TABLE OF CONTENTS

PART 0 PROJECT-SPECIFIC AMENDMENTS
PART 1 GENERAL
1.1 SUMMARY
1.2 SUBMITTALS
1.3 CLOSEOUT SUBMITTALS
1.4 DRAWING UNITS
1.5 SETUP AND REQUIREMENTS
PART 2 PRODUCTS (NOT USED)
PART 3 EXECUTION
3.1 REVIEW
3.2 CLOSEOUT ACTIVITIES

PART 1 - GENERAL

1.1 SUMMARY

A. The CAD and BIM requirements as described in this Section apply to all shop and fabrication drawings created by Contractors, their subcontractor, and vendors for a specific project. These requirements also apply to specialty engineers' documents, such as substation design.

B. Related Requirements:

1. VDC BIM Standards
2. VDC BIM Drawing Standards
3. VDC BIM Execution Plan (BXP)
4. Section 013100 – Project Management and Coordination
5. Section 017700 - Closeout Procedures
6. Section 017839 - Project Record Documents
7. CAD Standards for Civil (UID: 15743) for any CAD standards, if needed. The information contained in CAD Standards for Civil supersedes and replaces information in this document.

1.2 SUBMITTALS

C. BIM 360 Project Management module shall be used for the submission, tracking, and approval of all project RFIs and Submittals. The Owner will provide access to the module as part of the Owner's overall BIM 360 common data environment.

D. If DWG-based software is used for shop drawings, the following DWG requirements must be followed.
1. Software name and release must be documented in the BXP.
2. Add-ons or custom tools used in the creation of the file that are needed for updating the drawings must be documented in the BXP.
a. Doc Control system metadata requires listing software name.
3. DWG files must be saved in the DWG 2018 format, used by AutoCAD 2018 through 2023.
4. DWG files must follow the standard set in Owner's Miso-C3D.ctb file, available from Owner's representative. The same .ctb file must be applied to all drawings from the subcontractor.
5. Layer and object transparency, gradient hatches, and wipeouts must not be used.

E. SHOP DRAWINGS
1. Shop and fabrication drawings must be derived from the Contractor's BIM coordination model.
2. If a shop drawing set falls into the "As-maintained" category, Revit must be used.
a. Exceptions to this requirement require Owner approval and must be documented in the BXP.
b. "As-maintained" category shop drawings include:
1) Fire Protection
2) Fire Alarm, Emergency
3) Automation, Controls
4) Security
3. Revit Exceptions:

a. If Revit is not used, the preferred software for shop drawings is AutoCAD, and must follow the minimum AutoCAD standards outlined below.
b. AutoCAD Standards:
    1) The Contractor must provide CAD backgrounds in DWG format (for floor and ceiling plans) to the Subcontractors.
    2) All trades must use the same set of backgrounds.
c. The A/E Revit models must have a dedicated floor and ceiling plan export view set up to facilitate Revit model change updates.

1.3 CLOSEOUT SUBMITTALS

F. The submitted CAD/BIM files at project closeout must comply with submittal and closeout requirements, as described in the A/E Project Specification: 01 33 00 - Submittal Procedures, and 017700 - Closeout Procedures.

1.4 DRAWING UNITS

G. DWG file units must be inches (imperial) or millimeters (metric).
H. All objects must be drawn accurately to reflect the file or block units. Adjusting units by scaling of reference files or blocks is not acceptable.
I. All diagrams, details and drawings created in Revit must be set up Full Scale / 1:1 and controlled by the sheet view scale settings. For documentation created in AutoCAD the same requirements apply with the exception of diagrams and schematics that can be drawn not to scale.

1.5 SETUP AND REQUIREMENTS

J. Building plan basepoint & orientation:
    1. All models must share the coordinate system established at the beginning of the project.
    2. This applies to all delivery phases and software environments.
    3. See “VDC BIM Standards: Coordinate Setup” and “CAD Standards for Civil” documentation for more detail.
K. Site plan:
    1. Shop drawings are not required for site utilities.
    2. Redline and detail any civil engineer’s drawings, according to Section 013100 Project Management and Coordination and Section 017839 Project Record Documents.
L. Annotations:
    1. Size and place text, dimension, and other annotation in a legible manner.
M. Schedules:
    1. Schedules must be generated from Revit and/or AutoCAD scheduling tools. Schedules must not be created from manual line and text objects.
    2. OLE objects must not be used.
    3. AutoCAD Table must be used for spreadsheets placed on drawings.
N. Model Space and Layouts in AutoCAD:
    1. All building geometry must be drawn in model space.
    2. Layout (previously known also as paper space) must have geometry that is scaled by using viewports.
        a. Multiple layouts per DWG file are acceptable when drawings share the same model space, as with floor plans stretching over multiple sheets.
    3. Unused layouts must be removed from files.

4. When using multiple layouts, names must refer to the sheet number only, not the drawing name.
5. Annotations must be placed in a file's model space to reduce file proliferation in other sheets and to facilitate layer management.
    a. Exceptions: Repeatedly shown information such as grid bubbles, grid dimensions, or room names.

O. Printing:
1. Digital files (PDF, DWF) must reflect the actual paper size (the scale of the drawing) and must not be scaled down or set to "scale to fit."
2. When using AutoCAD:
    a. A sheet set must be set up for the project that can be used for batch plotting, e-transmitting, and archiving.
        1) Only the sheet set's Sheet List tab must be set up.
        2) Sheet sets can be by individual trade but must reflect the drawing index accurately.
        3) The sheet set must be included when posting files.

P. Sheets:
1. Files must be prepared for batch printing.
2. Each sheet must have a default page set up for full-sized PDF.

Q. Scales:
1. Standard metric or imperial scales must be used.
2. Random scales must not be used.

R. Language:
1. All text must be provided in both English (American) and the official regional language, where applicable and approved.
2. English must be included in all submittal documents; separate, translated documents must not be included.
    a. Examples: Commissioned equipment, HVAC, plumbing, piping, electrical, and security systems.

S. Drawing Set Organization, Sheet Numbering, and File Naming:
1. Sheet organization must be logical, that is, sequential.
2. Sheets and files must be logically named to allow future users to easily find and understand them.
3. Use the discipline designators.
    a. Disciplines and Drawing Set Order:
        1) G - General (00)
        2) C - Civil (01)
        3) L - Landscape (02, not used often)
        4) S - Structural (03)
        5) A - Architectural (04)
        6) I - Interior Architecture (limited to FSA Area/Office Remodel Projects) (05)
        7) M - HVAC (06)
        8) P - Plumbing, Process Piping (07)
        9) FP - Fire Protection (08)
        10) E - Electrical (09)
        11) FA - Electrical-Fire Alarm / Emergency (10)
        12) SC - Security (11)
        13) AC - Building Automation / Controls (12)
        14) T - Telecom (CCNR/SSNR; IDF and MDF Rooms) (13)

15) FF - Furniture (14)
16) SG - Signage (15)
17) FS - Food Service (16)
18) EHS - Environmental Health & Safety (for evacuation maps and similar) - No number assigned, as this set is not included in A/E construction drawings.

b. Sheet Chapter Numbering:
1) -000, 001 General information, symbols, abbreviations and sim.
2) -100, 101 Site plans
3) -200, 201 Floor plans, ceiling plans, framing/foundation plans, overall and partial plans
4) -300, 301 Overall building sections and elevations
5) -400, 401 Enlarged plans (from 1/4″=1’-0″ [1:50] and smaller)
6) -500, 501 Diagrams (single-line, risers, controls)
7) -600, 601 Schedules
8) -700, 701 Vertical Circulation (framing plans, enlarged plans, sections, details)
9) -800, 801 Details
10) -900, 901 Misc, Permitting
11) Four-digit sheet numbering can be used as needed.

T. Drawing Index Sheet:
1. An index listing the sheet numbers and names must be included as part of each submittal.This index can be a comprehensive spreadsheet or an individual index for each discipline.

U. File Names Format:
1. These minimum requirements must be followed for any DWG files used on projects (not limited to sheet files):
a. File name must include discipline prefix, sheet number, and meaningful descriptions
1) Example: FP-101_1st Floor Fire Suppression Plan.dwg
b. File names must include a range of sheets when drawings utilize multiple paper space layout tabs.
1) Example: FP-101-110_Fire Suppression Plans.dwg.
c. Name layout tabs in paper space must be the same as the sheet number.
d. File names must be limited to 64 characters maximum.
e. File names must not be changed after issuance.
f. Filenames must not use symbols (, . / ! ? $ # “ ; @, and so on).

V. Numbering and Naming:
1. File names and numbers must not be changed from the A/E sheet convention.
a. Exception: Room names, equipment tags, and similar may require a more stringent naming and numbering convention (Example: equipment naming taxonomy). Exceptions require Owner approval.

W. AutoCAD Layers:
1. Layer name logic must be consistent and as simple as possible.
2. Layer names must not use symbols(, . / ! ? $ # “ ; @ and so on).
3. Nothing must be placed on layers *0* and *Defpoints*. *0-NO-PLOT* and *0-BLOCK* layers may be used instead.

X. File Exchange and Posting:
1. All procedural requirements mentioned in the A/E project specifications must be followed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 REVIEW

Y. Shop drawings must be reviewed at closeout for the following requirements. This applies to Revit and AutoCAD/DWG derived shop drawings and to all new construction projects. Payment is conditional upon requirements compliance.
   1. Exception: Product cut sheets or similar generic drawings need not comply with these requirements.

Z. External References (Xrefs):
   1. When using external references, this Xref structure protocol must be followed:
      a. Xrefs must not be bound.
      b. The Xref folder structure must be maintained.
      c. Xrefs must have a relative path. The project's DWG files must be audited and purged.
      d. The hierarchical levels of nested Xrefs must be kept simple.
      e. Overlaid and attached Xrefs must be avoided.
      f. Referencing the same files multiple times at different hierarchy levels must be avoided to ensure easy layer management.
      g. The use of several subfolders is allowable, but relative paths for Xrefs and images must be assigned.
      h. XCLIP must only be used for meaningful instances.
      i. Reference files must be kept to a minimum.
      j. Content that is only shown once in a drawing set can be directly placed in the sheet file's model space.
         1) Example: details, diagrams.
      k. All unneeded, unreferenced, outdated Xrefs must be detached before submitting.

AA. 2D and 3D Drawing Accuracy:
   1. Models and drawing must be accurate and to scale.
   2. Orthogonal lines must be straight and corners must meet.

3.2 CLOSEOUT ACTIVITIES

BB. At project closeout, unless requested earlier, a zip file must be provided that includes all files required to recreate the files and maintain them. This file must include custom fonts, pen weight, images, and other files and references needed to constitute a complete document.

CC. A comprehensive list of abbreviations used on the shop/fabrication drawings must be provided.

DD. Content on frozen or turned off layers:
   1. Remove unrelated linework from DWG files. Include only linework that is on the printed sheets.

EE. Native CAD/BIM files created in software other than Revit and AutoCAD must be included.
   1. Examples: Tekla or AutoSpink.

FF. Posting native files:

a. Use the e-transmit function from the project's sheet set.
b. When etransmitting from AutoCAD:
   1) Do not downsave.
   2) Do not explode AEC objects and AUTOCAD blocks.

END OF SECTION

REVISION HISTORY

Version	Date	Description and location of change
1	August 2021	Initial release as a specification. This spec (013324) is a conversion of the narrative, Appendix J CAD/BIM Instructions to Contractors.
2	January 2022	Added "CAD Standards for Civil Guideline (UID: 15743) for any CAD standards, if needed. The information contained in CAD Standards for Civil v1 supersedes and replaces information in this document" to the Related Requirements list in Paragraph 1.1: B. Revised 1.2: B2 to "Save all DWG files in the DWG 2018 format, used by AutoCAD 2018 through 2022."
3	January 2022	Removed "v1" from CAD Standards for Civil in 1.1:B6.
4	September 2022	Updated Part 0 instructions.
5	March 2023	–Aligned requirements language to conform with VDC document set. –Changed section 1.5 Header from "Base Point and Orientation" to "Setup and Requirements."

SECTION 013523
OWNER SAFETY REQUIREMENTS

TABLE OF CONTENTS

PROJECT-SPECIFIC AMENDMENTS

GENERAL

PRODUCTS (NOT USED)

EXECUTION (NOT USED)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and the Construction Agreement, including any Amendments thereto, and other Division 01 Specification Sections apply to this Section.

1.2 RELATED REQUIREMENTS

A. Applicable Sections: Division 01.

B. Section 011000 - Summary.

C. Section 013100 - Project Management and Coordination.

D. Section 013200 – Construction Progress Documentation.

E. Section 013553 - Construction Security Requirements (YAWN).

F. Section 013553.11 - Security Construction Staffing and Expectations.

1.3 CONSTRUCTION MITIGATION MEASURES AND IMPLEMENTATION

A. Contractor shall implement construction mitigation measures identified and agreed to during design phase as listed in the project design risk assessment (DRA).

B. Contractor shall document evidence of mitigation implementation in the project DRA under DRA Column titled: Mitigation Measure at Construction Phase for all risks on the DRA that are designated as having risk transfer to Construction. Examples of evidence include: Contractor Health & Safety Plan (HASP), Construction schedule, sub-contractor job risk assessments (JRAs) and/or other documents that provide proof of contractor mitigation implementation. Note: Evidence will be periodically audited by Owner's Construction Safety Facilitator (CSF) throughout the project.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

3.1

END OF SECTION

REVISION HISTORY

Version	Date	Description and location of change
1	March 2021	Initial version.
2	September 2022	Updated Part 0.

SECTION 013523.1
CONSTRUCTION INCIDENT NOTIFICATION

TABLE OF CONTENTS

PART 0 PROJECT-SPECIFIC AMENDMENTS

PART 1 GENERAL
1.1 SUMMARY
1.2 REFERENCES
1.3 CONSTRUCTION INCIDENT NOTIFICATION REQUIREMENTS

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

PART 1 - GENERAL

1.1 SUMMARY

A. The intent of this document is to provide a uniform notification and communication process for reporting incidents at data center construction sites. This process is written to assist Contractors managing a construction site to understand the reporting requirements and process.

B. This process is also intended to provide guidance for internal stakeholders so they may better understand how and when to expect notification and updates when an incident arises during construction.

C. This process outlines procedures specific to buildings under construction at Yawn data center sites. Please see the " How to report an incident after facility turnover" section of this document for the process in the operational data center.

D. Section Includes
   1. Procedures specific to buildings under construction at YAWN data center sites
   2. Definitions
   3. Incident types
   4. Incident notification and communication and responsibilities
   5. Reporting an incident after facility turnover
      a. Communications
      b. Near-misses at YAWN and operational data centers

1.2 REFERENCES

E. Abbreviations and Acronyms
   1. GSM - Owner Security Manager
   2. SSM - Site Security Manager
   3. CSM - Construction Security Manager

F. Definitions
   1. Owner Security Manager (GSM) - The FTE who manages all aspects of physical security at an Owner data center.
   2. Site Security Manager (SSM) - The Owner vendor security manager who manages the vendor guard services and day to day security operations at the data center.
   3. Construction Security Manager (CSM) - The contracted construction security manager (typically sub-contracted to the Contractor) who manages the vendor guard services and day-to-day construction security operations at the construction site.
   4. Risk360 Reporting Tool - Physical security incident management and reporting system.

G. Reference Standards
   1. 013523 - Owner Safety Requirements

H. Incident Types
   1. The following categories and incident types require reporting in accordance with Risk360 Data Center Incident Notification requirements:
      a. Injury or medical events resulting in:
         1) Loss of life
         2) Loss of limb or eyesight
         3) Illness or serious injury requiring outside medical attention
         4) Any potential lost-time accident or serious-near-miss safety event (see SPE for the definition)

5) Illness or injury requiring first aid

b. Infrastructure events resulting in:
   1) Any occurrence posing a significant safety hazard or impact to the working environment
   2) Building evacuation
   3) Shelter event
   4) Release or spill
   5) Severe weather or natural event
   6) Major damage to a utility (on or near the site)
   7) Site shut-down

c. Security events resulting in:
   1) Any incident where emergency response services or law enforcement responds to a site who called, or on which a report is filed
   2) Vehicle accidents
   3) Theft
   4) Trespassing
   5) Suspicious activity
   6) Unauthorized access onto the site
   7) Acts of violence
   8) Active threat
   9) Significant property damage (non-vehicle)
   10) Discovery of illegal substance or paraphernalia

d. Site visits including:
   1) Government or regulatory agencies who show up unannounced or announced to perform investigations.

1.3 CONSTRUCTION INCIDENT NOTIFICATION REQUIREMENTS

I. The following roles have been established to ensure that incident notification and communication is as straightforward as possible:

1. Contractor
   a. For events requiring off-site assistance, make first call to emergency responders (police, fire, EMS).
   b. Make initial notification of all incidents to on-site construction security team for the purposes of emergency response support, assisting off site support services with immediate access, directing personnel and traffic, Risk360 report, and so on.
   c. Make initial notification and follow-up notifications to DCS on-site manager.
   d. Notify the DCS on-site manager if you receive any Notice of Violation/Investigation from Authority Having Jurisdiction (AHJ).
   e. Make initial notification and follow-up notifications with on-site Owner security manager.
   f. In instances where a GSM does not exist for the site, notify the acting GSM or RSM.
   g. Provide follow-up, final report, and any downstream root-cause analysis (as required or requested by client) to the DCS manager or the GSM.
      1) Risk360 incident notification reports will issue automatic notifications to specific recipients, based on incident type using programmed email aliases.
      2) If you are not receiving Risk360 email communication and you feel you should be, contact your local GSM or your manager to ensure you are added to the

appropriate email group (XXX-r360-notification@owner.com or XXXehsincidens@owner.com).

h. After facility turnover, Contractors remaining onsite aware of an incident are responsible for ensuring that Owner Security is notified (through the DCSOC) and provided with the incident details needed for reporting.
   1) CSRM, using the Data Center Security Operations Center (DCSOC), will be responsible for the initial notification of all incidents by way of Risk360.
      a) All incidents will be reported according to Risk360 reporting requirements.
   2) Serious near-miss safety events are not reported by operational security using the Risk360 tool. In the event of a serious near-miss, the normal Construction Incident Notification Process will apply, to include notification of DCS management.

2. Construction Security
   a. When notified of events, perform emergency response support
   b. Assist off-site support services with immediate access and escort
   c. Direct personnel and traffic, and so on, as required
   d. Initiate event notification through Risk360 reporting, under 'Construction'
3. DCS Manager
   a. Client point-of-contact for both internal and external incidents
   b. Management of, and ongoing communications related to, all incidents on the construction site or specific to construction activities
   c. Notify local Google management team and liaison as applicable
4. GDC CSRM
   a. Overall incident awareness and as-needed support for Risk360 reporting, and further incident notification and escalation
5. EH&S
   a. Local and regional support and as-needed assistance with root-cause analysis or corrective action procedures

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION

REVISION HISTORY

Version	Date	Description and location of change
1	June 2021	Initial version.
2	December 2022	Updated Part 0 instructions.

SECTION 013553
CONSTRUCTION SECURITY REQUIREMENTS (YAWN)

TABLE OF CONTENTS

PROJECT-SPECIFIC AMENDMENTS

GENERAL
- SUMMARY
- PURPOSE
- TYPES OF CONSTRUCTION
- PHASES OF WORK
- SUBMITTALS
- REQUIREMENTS

PRODUCTS (NOT USED)

EXECUTION (NOT USED)

PART 2 - GENERAL

2.1 SUMMARY

This document is intended to help its user:

A. Secure Owner data center sites during construction.

B. Protect the sites from unauthorized access, theft of Owner equipment, material, intellectual property (IP), site plans, and other confidential materials.

C. Provide security support services for the safety of personnel on the site.

2.2 PURPOSE

D. During construction, the site contains sensitive information such as design plans, Owner confidential documents and other forms of Owner IP, hardware, specialized electrical and mechanical units, and other items that are trade secrets or which represent a competitive advantage for Owner.

E. This document provides a clear set of requirements for Data Center Delivery Engineering (DCDE), Data Center Services (DCS), General Contractors (GC), and Owner Data Center Security (GDCS) to establish a comprehensive security program that satisfies the construction site security requirements through all phases of construction.

F. The GC, DCS (*see note), or possibly GDCS will hold and own the contract with the security vendor and will be billed directly for security services through the end of the project.

*__Note:__ The end of project is not a one-size-fits-all due to varying circumstances. Therefore, the end of project and discontinuance of security services will be coordinated through the GC and DCS in agreement with the GSM.

G. Security services will take direction from GC, DCS (*see note), or GDCS based on contractual relationship or as outlined in the SOW Agreement.

*__Note:__ *At some locations (as applicable), DCS will contract with the security vendor directly (outside of the GC). For those locations, DCS will discuss security arrangements and requirements with the GC in advance.*

H. All security implements and systems are owned by the GC until the points-of-contact handover to the Owner. All security processes, procedures, and requirements will be documented in a site-specific construction security plan. This document will be written and updated by the GC according to the requirements of this document and will be reviewed with the DCDE, DCS, and GDCS management. Final approval of the plan resides with GDCS management (that is, the GSM).

*__Note:__ Owner Security vehicles, uniforms, tools, and personnel should not be used for construction sites without prior collaboration and consent from DCS, DCDE, or the GSM.

I. The key words "**must**", "**must not**", "**required**", "**shall**", "**shall not**", "**should**", "**should not**", "**recommended**", "**may**", and "**Optional**" in this document are to be interpreted as described in RFC 2119.

2.3 TYPES OF CONSTRUCTION

J. **New Site** - Sometimes called "Greenfield," this type of construction can include sites ranging from literal green fields to existing buildings that are geographically separate from any existing data center campus.

K. **Adjacent Site** - This is any site that is geographically adjacent to an existing Owner data center, or are on operational data center campuses.

L. **Operational Site** - This is construction work being done within a section of an operational building and or operational site. This kind of site shall use Operational Security for the construction work, and security will not be provided by the construction security team. However, the GC shall explicitly coordinate with the GSM through all phases of construction ensuring operational compliance and minimal impact to site operations.

2.4 PHASES OF WORK

There are multiple phases of work that represent shifts in security at a construction site. This is applicable for both new sites and adjacent construction sites. The requirements detailed in this document begin at Phase 2 and start the transition to operational security at Phase 4.

- Phase 1 - Pre-Construction
- Phase 2 - Construction - (Arrival of Owner IP)
- Phase 3 - CCNR Ready
- Phase 4 - Facility Ready (FR)
- Phase 5 - Partial Hand-off (PHO) to Full Hand-Off (FHO)

***Note:** For specific timeline of security requirements associated with each phase of construction, see Paragraph 1.6:K.

2.5 SUBMITTALS

M. Logistics And Physical Security Plan

1. Prior to the beginning of Phase 2, a site logistics plan **must** be submitted to the owners for review in conjunction with the Construction Security Plan. The logistics plan shall be an overhead view of the site, indicating the placement of site components such as the main and ancillary roadways, gates, parking areas, delivery areas, pedestrian walk paths, laydown areas, construction trailers, lighting plan, emergency exits, and overall workflow.

2. Logistics plan must demonstrate how the GC will meet the security requirements within that logistics plan (that is, a logistics/security plan).

3. For each significant change or new phase of the project, a revised logistics plan and security plan will be submitted to DCS and CSRM for approval.

N. Submission of Construction Security Plan, including construction fence drawings documenting temporary and permanent fence outline for each Phase of Work (see 1.4). Fence design needs to show all construction phase fencing required for Contractor's use of site. It should make use of final security fencing as much as possible to avoid rework. A scale should be included on the drawings; a graphic scale is recommended.

1. Lot (Plot) Diagram. May include location and size of the lot; location and size (height and length) of the proposed fence; location and types of vehicular and pedestrian gates, width of the sidewalk if applicable; critical dimensions for the lot and fence lines

2. Security Type of Fence.

3. Additional information as deemed important for security design of fence. Submittals need to be approved by Owner's Regional Security Manager before construction commences.

2.6 REQUIREMENTS

O. Security vendor services
There are distinct benefits to using pre-qualified security services, but more important is knowing which security groups offer reliable service. To meet the requirements in this document, a reliable security service provider is necessary.
1. GDCS must approve the security service provider.
***Note:** For further assistance or information relative to qualified service providers, please contact GDCS.

P. Security staffing requirements
1. The intent of staffing requirements is to ensure compliance with the construction security plan, and to ensure staffing is appropriate to address both the size and complexity of a site. The number of guards required at greenfield is not the same as the number needed for a fully built structure.
2. Security staffing **should** conform to the standard in the Construction Staffing Expectations (Note: See Section 013553.11 - Security Construction Staffing and Expectations) with the understanding that site conditions, size, and complexity may alter the true number of security personnel required.

Q. Security training
It is the responsibility of the GC, DCDE, and DCS is to ensure the security services provider provides an optimal level of training to meet the following minimum security training requirements.
1. Each security officer must be properly trained, qualified, and licensed (as required by jurisdiction) to perform the tenants of the job including, but not limited to:
- General access control
- CCTV monitoring
- Vehicle and foot patrol
- Report writing
- Emergency response

2. Site-specific training (for example, site-specific access control, site safety, local laws and code, emergency response, and so on)
3. Some level of on-the-job training prior to working independently

R. Security equipment, tools and resources (Phase 2)
Note: Critical positions such as Construction Security Manager (CSM) and Supervisors will require Owner provisioning. This will provide these critical positions with access to required Owner resources such as email, training material, R-360 incident reporting, and so on.
Vendor security personnel shall have access to the following equipment, tools, and resources:
1. Security patrol vehicles to meet site coverage, including, at a minimum:
   a. One company vehicle for roving patrol
   b. One golf cart (buggy) for post rotations and emergency response
2. Computer equipment for management and supervisory duties, general administrative duties, training, and each post assignment requiring access control (Access Control List) and CCTV monitoring. The computer equipment may include a combination of desktop computers, laptops or chromebooks.
3. Access to the sites Access Control List (ACL) at all times
4. Access to, and the ability to monitor, the CCTV system at all times from at least one centralized location
5. At least one (1) primary cell phone issued to the CSM and at least one (1) primary cell phone issued to contact the security teams or supervisors and to respond to security escort requests, emergencies as needed
6. Security post which, if exposed to outdoor elements, shall have an environmental shelter or enclosure (security booth) with climate control
7. Two-way radio system and associated radios to equip all security officers on shift at any given time
8. Emergency weather alert system
9. Personal Protective Equipment (PPE) - which **must** include, at a minimum, composite-toe shoes, hard hats, safety vests, gloves, and eye and hearing protection
10. Weather-appropriate equipment to accommodate the regional climate
11. Flashlights
12. Access to keys and locks specifically associated with access control portals, doors, and offices
13. Lockable key box
14. Access to all badging-related supplies (such as badges, lanyards, and badge printers)
15. Dedicated label maker and associated supplies
16. At least one dedicated printer and access to copiers and laminators for as-needed use
17. Digital camera specifically for use by Security as needed for investigations, equipment damage reports, and so on
18. Digital cameras specifically for use in accordance with the Construction Photo Policy
19. General office supplies, such as pens, notepads, and folders
20. Lockable filing cabinet
21. Small safe for storing sensitive items
22. Any other items requested by security vendor management (within reason) that may be needed to perform the security services in accordance with the requirements of this document

S. Reporting requirements (Phase 2)
1. The GC is responsible for reporting **all** construction site safety and security incidents to the security team to ensure awareness and compliance with owner requirements.

2. A Risk360 report **must** be filed in accordance with DCDE Construction Incident Notification Procedure. (Note: See Section 013523.1 - Construction Incident Notification.)
3. For every safety and security incident by security.
   a. All incident reports should follow the R360 Categorization Guidelines.
   b. Notification of Life Safety Incidents **must** also be reported to EHS teams.

T. Site authorization and access control requirements (Phase 2)
All personnel on site shall be known individuals. This is ensured by having strict access control requirements established as early as possible in the construction process. However, at the commencement of Phase 2 - Construction, an established access control process shall be in place in accordance with the requirements outlined below and documented accordingly within the construction physical security plan.
   1. A formal documented access control program must be established prior to the commencement of Phase 2 - Construction. This program shall coincide with the site logistics and physical security plan. Final approval of the Site Access Control Program resides with DCS and GDCS (GSM). Any changes or revisions shall be communicated with the DCS and GDCS (GSM) for review and approval prior to implementation.
   2. The access control program shall consist of the following requirements:
      a. An access control management system should be implemented as early on in the construction as possible, but no later than the start of Phase 2.
      b. The access control management system shall have an associated database that is managed and maintained in real time with retention of all access control activity upon implementation of the access control system through the end of the project. This system and database shall be on back-up power supply.
      c. A documented workflow process will be used for requesting, reviewing, approving, and denying access to the site. This will also include the process for notifying security of approved and denied requests and when to add or remove site access.
      d. A documented workflow process for all approved deliveries and delivery vehicles.
      e. A list of GC personnel responsible for reviewing and approving access to the site will be used.
      f. A current copy of the site Access Control List (ACL) **must** be available at all times to Security and available at all primary entrances, secondary entrances, and any other access portals (gates, turnstiles, and so on) that allow ingress to or egress from the site.
      g. When possible, the ACL should be accessible to security personnel through laptops, chromebooks, and notepads to ensure they are working off the most current list.
      h. The GC **must** physically control and maintain the list, ensuring it is updated each day.
      i. The ACL **shall** include all authorized personnel including workers, visitors, and deliveries for each specific day.
      j. The only personnel authorized to change the access list are the GC's responsible access control management (such as a project manager, or senior superintendent) in agreement with the Owner's DCDE PgM or their designee.
      k. A designated site "watch list" consisting of personnel removed from the site for reasons of theft, threats, acts of violence or similar acts, shall be maintained and updated by the GC and Security, and shall be accessible at all times.
         1) When an individual is added to the "watch list" for reasons of theft, threats, acts of violence or similar acts, notification **must** be sent to Owner's Security Management (GSM/RSM).

3. Site Authorization Requirements:
   a. The GC **must** have a process in place that ensures all personnel receive the required site safety orientation and sign the appropriate Owner NDA prior to gaining authorization for site access.
   b. The GC **must** have a process in place ensuring all contractors and all associated subcontractors conducting work on site successfully complete a background check and substance abuse testing prior to gaining authorization for site access. In the absence of local jurisdictional restrictions, the background must include the following.
      1) For all contractors and all associated subcontractors performing **any** work within an operational data center space, including construction areas that have been turned over to operations, the background check **must** include, at a minimum:
         a) Criminal court check (all counties of residence and work for prior seven years)
         b) Social Security Number trace
         c) Federal Criminal Database search
         d) Global Watch List / Terrorist Watch List
         e) National Sex Offender Registry
         f) For all contractors and all associated subcontractors performing work only within construction areas (i.e. non-operational data center spaces), the GC background check process must include sufficient diligence such that the GC is reasonably certain that the contractor/associated subcontractors do not present a risk to the safety and security of the construction site.
      2) The substance abuse testing **must** include a SAMHSA-approved minimum 10-panel drug test.
      3) No personnel provided by the GC may perform any services on site until the GC sends written notification (by email) to the DCS PgM that the applicable requirements in (1) - (3) have satisfied the background check and substance abuse testing and results did not produce any findings and the DCS PgM approves the results of the GC's notification of no findings.
   c. For those sites within an operational data center space where the One Source program is deployed (in cooperation with DCS), the GC and all associated subcontractors **must** meet all background and substance abuse testing requirements in accordance with One Source Certified Contractor: Level 2+ Guidelines.
   d. The One Source program provides a certified and consistent process that ensures all of Owner's background and substance abuse testing requirements are met.

      ***Note:** For more information about One Source Background and substance abuse testing, see One Source Frequently Asked Questions.

4. Entry to Site:
   a. Assigned Personnel:
      1) Prior to the assignment to site, assigned personnel will have to request access to the construction site through the GC.
      2) Upon arrival, assigned personnel **must** produce a valid government-issued picture ID to receive an approved permanent construction badge.
      3) All personnel entering the site by foot **shall** enter the site through the designated security access control points.
      4) All motorized vehicles entering the site **must** enter the site through the designated vehicle gates prior to entering the construction site.

5) All passengers of motorized vehicles **must** be authorized to enter the site and must possess a valid, approved construction badge.

b. Visitors:
1) All visitors (anyone who does not work on the construction site) coming onto the construction site **must** request access to the construction site through the GC.
2) All visitors **must** produce a valid government-issued picture ID to receive an approved temporary construction visitor badge.

***Note:** In instances where government officials decline showing ID, security shall escalate to GC management for further direction.

3) Anyone with a visitor badge **must** be escorted by an authorized individual at all times in accordance with escort requirements.
4) All visitors entering the site by foot **shall** enter the site through the designated security access control points with their escort.
5) All visitors entering the site by motorized vehicle **must** enter the site through the designated vehicle gates with their escort.

5. While on Site:
a. Assigned personnel:
1) All authorized personnel on site **must** have a site badge visibly displayed at all times. The site badge **must** be displayed in a clear pouch, attached to hardhats, or worn on a breakaway lanyard.
2) All authorized personnel on site shall follow access-related security rules at all times.

b. Visitors:
1) All authorized visitors on site **must** have a construction-issued Visitor badge visibly displayed at all times. The site badge **must** be attached to breakaway lanyard that clearly displays "VISITOR - ESCORT REQUIRED."
2) All authorized visitors on the site shall follow access-related security rules at all times.

6. Exit from Site:
a. Assigned personnel:
1) All personnel exiting the site by foot **shall** exit the site through the designated security access control points.
2) All motorized vehicles exiting the site **must** exit the site through the designated vehicle gates.

b. Visitors:
1) All visitors exiting the site by foot **shall** exit the site through the designated security access control points with their escort.
2) All visitors in motorized vehicles exiting the site **must** exit the site through the designated vehicle gates with their escorts.

7. Site personnel permanently removed from the site (voluntarily or involuntarily):
a. The following steps **shall** be followed upon individuals being permanently separated from from site:
1) The responsible manager **shall** notify security in advance when feasible.
2) The responsible manager **shall** collect badges.
3) The responsible manager **shall** turn in collected badges to security upon receiving or retrieving them.
4) Security **shall** ensure badges have been collected and access removed accordingly upon receiving badges.

8. Vehicle Search Requirements
   a. Security kiosks and pre-designated areas for the purpose of search **must** be configured in a way that demarcates an area to properly and safely accommodate these search tasks without impacting the traffic flowing into or out of the site.
   b. Delivery Vehicle Search Requirements
      1) To ensure no unauthorized persons are granted unauthorized access onto the site, the GC's access control standard for delivery vehicles shall entail searches of delivery vehicles coming onsite.
      2) The GC shall ensure the delivery vehicle search process is established to be random, capturing approximately 33 percent of site deliveries.

      *** Note**: During times of elevated threat, the search requirements may be subject to 100 percent search as necessary, and will be directed by GDCS management.

         a) These searches will consist of:
            i. A cursory search of the delivery vehicles perimeter
            ii. A search of the delivery vehicles cabin (including the passenger compartment)
            iii. A visual check of the delivery vehicles cargo areas
         b) These searches do not include:
            i. Sealed trucks from partner companies
            ii. Shuttles
            iii. Guards entering vehicle trailer or container to perform search
            iv. Packages or boxes inside vehicles

      *** Note**: To achieve the balance of security and productivity, frequency and depth of the vehicle searches may be altered by the RSM/GSM of the site, based on changing conditions.
   c. Regular screening of individuals leaving the site are also required to ensure there is no unauthorized removal of IP or Owner's materials.
      1) The GC shall ensure the screening process is performed randomly or as necessary (such as during an elevated risk) and capturing 25 percent of all vehicular traffic leaving the site, with effective measures to ensure the prevention is effective in deterring the removal of Owner IP or materials.
         a) These searches will include:
            i. A visual check of the vehicles perimeter
            ii. A visual check of the vehicle's cabin (including the passenger compartment)
            iii. A visual check of the vehicle's cargo areas (trunk, truck bed)

      *** Note:** Owner retains the right to independently test these processes as well.

U. Construction site minimum security requirements (Phase 2)
*In order to properly maintain security at an Owner DC construction site, a minimum set of security requirements must be in place. In concert with the operational requirements, this provides the security posture for the construction site. The following requirements **must** be in place at the commencement of Phase 2.*
   1. Perimeter Fence
      a. A perimeter fence **must** be installed to mitigate attempts at unauthorized entry to the site, with no unmonitored access to the site through gates and turnstiles.

b. The Perimeter fence **must** be a total of 10 feet high (including 1 ft of barbed wire as permissible by local laws) and designed to dissuade climbing. The fence shall consist of the following minimum requirements:
   1) Chain link fence
   2) Three-tier cross bars (top, middle, bottom)
   3) Three-strand barbed wire (1ft), at a 45 degree angle facing outward (nonsecured side)
c. Installing the permanent site fencing prior to beginning construction, when possible, is advisable. If this is not possible, a temporary fence **shall** be installed, meeting the same requirements as outlined in subparagraph 1.6:G1.
d. Key points of entry and egress (specifically, security guard houses and traffic arms) **shall** be set up for people and vehicles , and **must** ensure the identity of individuals coming onto the property can be verified before allowing them access. This authorization also applies to client equipment and technology leaving the site.
e. Access control mechanisms **must** be in place to prevent unauthorized access to the site.
f. Access controlled gates **must** prevent all unauthorized individuals from entering the site.

2. Lighting
   a. Lighting **must** be sufficient for comprehensively illuminating fence lines, site entrance, construction support areas, personnel support areas, and common spaces.
   b. Lighting **must** be sufficient for allowing positive identification of individuals in and around the site, including areas within 10 feet of the secure area fencing.
   c. Lighting on the fence line **must** be sufficient for facilitating the identification of all intrusion attempts.
   d. Lighting in all areas **must** be sufficient for carrying out normal security functions in all reasonable weather conditions.
   e. In areas where permanent lighting cannot be established, temporary lighting may be used.
   f. All lighting, whether permanent or temporary, shall meet the lighting illumination requirements from dusk until dawn.
3. Camera Coverage and Monitoring
   a. Camera systems **must** be able to comprehensively cover fence lines, site entrance, construction support areas, personnel support areas, and temporary restroom facilities' common spaces.
   b. Camera quality **must** be sufficient enough to enable the positive identification of individuals in and around the site, including areas within 10 feet of the secure area fencing.
   c. Cameras on the fence line **must** be able to capture all intrusion attempts.
   d. Cameras in all areas **must** be sufficient for carrying out normal monitoring and assessment functions in all reasonable weather conditions.
   e. Site cameras **must** be accessible by security for monitoring purposes from at least one security post location at a minimum.
   f. AllL cameras associated with the comprehensive camera system **must** constantly be recording.
   g. Video retention for all cameras **must** be thirty (30) days minimum.

4. Zone Separation
   a. Expectations:

1) Prior to turning over any construction space to operational space, a coordinated plan shall be defined by the GC and agreed to by DCS and the GSM to ensure operational security requirements can be met and maintained.
2) There **must** be clear delineation between construction zones and operational zones in the project.
    a) This typically will occur at Phase 4 FR. Depending on the layout of the site and the process for turning over construction space to operational space, delineation lines may vary.
3) Access control for both personnel and vehicles between these zones **must** be defined and managed in accordance with operational security requirements.

b. Requirements:
1) To ensure the delineation between construction and operations can satisfy operational security requirements, the following will be required:
    a) Fence lines must meet requirements as outlined in subparagraph 1.6:G1
    b) Lighting must meet requirements as outlined in subparagraph 1.6:G2
    c) CCTV coverage must meet requirements as outlined in subparagraph 1.6:G3
    d) Doors must be lockable and alarmed
    e) Fabricated entry and exit points that compliment access control requirements such as MACs must meet OPR requirements.

    ***Note:** The temporary delineation requiring items from subparagraphs 1.6:G4b1)a) to 1.6:G4b1)e) above **must** be tied into the Owner's corporate network/security system. The temporary system configuration will require power, back-up power, Owner network connection, ISTAR panels, and end-of-the-line devices (DPS, card readers, and so on).
2) In addition to the temporary security measures delineating construction and operation, a temporary badging office (commonly referred to as construction lobby) will be required.
    a) This will support the high volume of badge issuance and return for construction personnel requiring approved badge access into the operational areas to complete work and punch list items.
3) The construction lobby configuration should accommodate two badging windows equipped with applicable office furniture (desk, chairs, lockable cabinets, and so on).
4) The construction lobby **must** be tied into the Owner's corporate network/security system. Including the means to connect, at a minimum, two Owner's corporate workstations.
5) To satisfy operational security requirements, the construction lobby must be equipped with the following:
    a) Power, back-up power, ISTAR panels, end of line devices (such as DPS, card readers, and motion detectors) and lockable doors and windows.

5. Vehicle barriers and traffic control devices (cones, candlesticks, speed bumps) should be placed in high-traffic areas to manage traffic flow and the speed of vehicles.
6. Signs must be posted and clearly visible at site entry points to notify personnel of possible search and denied entry for anyone that refuses to be searched, of video surveillance being in use, of tailgating policies, and of other such security information.
7. Graffiti Control (Specific to written threats and harassment messages)
    a. The following steps **shall** be taken to dissuade any graffiti from occurring.
        1) Lighting **should** meet requirements listed above in the Physical Security (fences, cameras, barriers) section.

2) Port-a-potties and bathroom trailers **shall** be grouped together and fenced with a single point of entry and exit
3) The single points of entrance to and exit from the Port-a-potty cluster **shall** have continuous camera coverage. Additional camera coverage may be required based on the size of the cluster.
4) Bathroom trailers are preferred to individual port-a-potties. In instances where a bathroom trailer is deployed, it is recommended to install badge readers on the trailer doors.
5) The security vendor **must** provide a roving patrol to check all restroom facilities on a frequent and routine schedule.

***Note:** the following Construction Site Restroom Configuration & Controls (Note: See owner's representative for Construction Site Restroom Configuration & Controls.)

b. Should graffiti be found, then construction security should work with the GC to investigate, and an R360 may be written after approval by the GSM/RSM.
   1) Additional actions to take should include the following:
      a) Assess the situation
      b) Secure the scene or area
      c) Take photos or videos
      d) Report to local law enforcement
      e) Coordinate the repair of damage

8. High Risk Terminations
   a. The following process shall be used for high risk terminations.
      1) High risk terminations include personnel who pose a serious threat to site safety and security. The following steps shall be taken by the GC in coordination with DCS and Security:
         - Step 1 - Access analysis (First step prior to termination)
           - Determine how the employee is able to physically or digitally access the work environment.
         - Step 2 - Termination (Should be done off of Owner property)
           - Coordinate how, when, where, and who will be involved in the actual termination. Remove all access items **prior** to termination. (disable program logins, badges, keys, key cards, and so on).
         - Step 3 - Motive analysis (First step after termination)
           - Determine if the terminated employee has any motive to engage in harmful actions against the site, personnel or Owner.
         - Step 4 - Mitigation
           - Determine if preemptive measures should be taken to protect the facility or infrastructure.
           - Protect against any exposures found after conducting the motive and access analyses.
           - GDCS (GSM) must be notified of all terminations determined to be high risk by the GC, including all cases that involve threats to personnel on the site.
         - Step 5 - Resolution

- Quarantine (do not erase) the former employee's computers and laptops until all pending investigations by the GC, GDCS, and law enforcement are complete.

9. Use of Drones During Construction (Drone and Aerial Photography)
   a. Prior to flying a drone on, in, or around the construction site, or prior to a known aerial photo capture (such as by Plane or helicopter) the following requirements shall exist:
      1) Provide advanced notification to Security, including:
         a) Date and times of flight
         b) Operator name and company
         c) General flight location and pattern
      2) Adherence to all FAA and local ordinance regulations
      3) Adherence to policy requirements outlined in DCDE Construction Photo Policy (Drone). (Note: See Section 013233.11 - DCDE Construction Photo Policy.)

V. Equipment and Intellectual Property (IP) requirements (Phase 2)
At various points in construction, Owner IP and property may be located on site. When this is the case, there are expectations that these items will be secured against loss.
   1. All Owner equipment or materials, site plans, documents, and Owner IP **must** be fully securable and auditable and, when not in use, these items must be secured. The following should be considered for control measures:
      a. Locate behind lockable badge reader equipped doors
      b. Use lockable repository boxes,cabinets, or cages
      c. Use CCTV to monitor these rooms and repositories
   2. Purchasable or transferable equipment and materials, such as items that are used to deploy and maintain the site and which **must** transition from general construction to Owner, **should** be fully securable and auditable.

***Note:** *All personnel on site shall have clear expectations of potential screening for unauthorized removal of Owner property.*

W. Project signage (Phase 2)
   1. All project signage **must** be pre-approved by DCS.
   2. Site entrance signage should contain the physical street address and any other jurisdictional requirements, at a minimum.
   3. Signage **must** be in place prior to Phase 2 to ensure that emergency services can appropriately respond to the correct location in the event of an emergency.

X. Additional requirements (Phase 2)
   1. The site **must** adhere to DCDE Construction Photo Policy (Drone). (Note: See Section 013233.11 - DCDE Construction Photo Policy.)
   2. The GC **must** create a safe vehicle turnaround area for vehicles denied access to the site. This vehicle turnaround **must** be located on the non-secure side of the entrance.
   3. In locations where construction zones are shared with or in close proximity to operations zones (for example, construction in a building that is in an operational area), regular meetings **should** occur between the security leadership representing the GC and Owner Physical Security Operations.
   4. Job seekers are not allowed to enter the construction site if their name is not on the authorized personnel access list.
      a. The GC **should** provide security with a handout that can be given to job seekers who are not authorized to enter the site, or post signage directing people to a receptionist.

The handout **should** contain information regarding job opportunities or instructions for applying.

5. The GC **must** include accommodations to allow for 24/7 site access for emergency service vehicles.
   a. GS should consider demarcating a location onsite or near the site for emergency helicopter services, such as Life Flight.

Y. Phases of construction and security requirements timeline
   1. Please see the following matrix, which outlines the phases of construction and the security requirements timeline. Please note that timelines may fluctuate site-by-site due to various circumstances.

Phase	Timeline	Security Requirements	Audit Required
Phase 1 Pre-Construction	FR -30 months	N/A	No
Phase 1 to Phase 2 Transition to Construction - Site acquisition - Site Utilities - Master Planning - Mobile Trailers configured and in use - Land Prep begins	FR - 30 months to -15 months	- Perimeter fencing defined - Gate controls - Lockable trailer doors - Access Control	No
Phase 2 Construction - Site DC Construction begins	FR -15 months	All security requirements apply in accordance with this document	Yes

Z. GDCS construction security audit process
   1. The above requirements are subject to audit by Owner or Owner's partners at any time during the construction process.

PART 3 - PRODUCTS (NOT USED)

PART 4 - EXECUTION (NOT USED)

END OF SECTION

REVISION HISTORY

Version	Date	Description and location of change
1	March 2021	Initial version.
2	April 2021	Removed references to the Project Manual. Added section number for DCID Construction Photo Policy.
3	June 2021	● Changed references of "DCID" to "DCDE." ● Changed "See DCDE Construction Incident Notification Procedure in the Vendor Portal" to "See Section 013523.1 - Construction Incident Notification." ● Changed "See Construction Site Restroom Configuration & Controls in the Vendor Portal" to "See owner's representative for Construction Site Restroom Configuration & Controls."
4	September 2022	● Background check requirements separated for YAWN and MARCUS projects. ● Updated Part 0 instructions.

SECTION 013553.11
SECURITY CONSTRUCTION STAFFING AND EXPECTATIONS

TABLE OF CONTENTS

PROJECT-SPECIFIC AMENDMENTS

GENERAL
- SUMMARY
- STAFFING MODEL
- PERFORMANCE EXPECTATIONS BY POSITION

PRODUCTS (NOT USED)

EXECUTION (NOT USED)

PART 1 - GENERAL

1.1 SUMMARY

The purpose of this document is to outline the GDC Security expectations for guard force performance during the construction of an Owner Data Center. This document will be used by the General Contractor for staffing, and Vendor Security Management to develop operational policies.

1.2 STAFFING MODEL

See YAWN Construction Security Staffing (UID: 27250).

The current model for a minimum approved guard force presence. The model is aligned with the phases of construction to balance protection with operational efficiency. However, sites which are in phased construction (i.e., half floor is FR), OR utilize non-guard force resources may upon approval run below these minimums, assuming expectations are met.

1.3 PERFORMANCE EXPECTATIONS BY POSITION

A. Site Manager
   1. The Construction Security Manager (CSM) manages the day-to-day supervision of all security staff providing support in administrative, training, and operations for officers assigned to the site. The site manager is responsible for directing all security activity on the site to include coordinating emergency response and relationship with clients. In addition, the follow tasks will be executed by, or at the direction of the CSM
      a. Staffing all security posts with qualified and trained personnel. Responsible for the immediate notification and reporting of all incidents at the site. Accounts for all security equipment each shift, collects site metrics
      b. Oversees the notification of maintenance security issues and ensures all security safety items are completed to site specifics. Check posts to ensure officers are following assigned site specific post orders, and standard operating procedures (SOPs).
      c. Respond and provide security support/leadership during all site emergencies.
      d. Responsible for the inventory of keys and sensitive items on a daily/weekly basis.
      e. Provides insight support for client on all security related issues while ensuring that all employees have completed their pre-site training, continue site specific security training.

B. Access Control/Kiosk Officer
   1. Officers working the Gate must be aware of their surroundings, and maintain accurate logs of all traffic coming through the gate. In addition to these duties, the Gate Officer must:
      a. Ensure all persons and vehicles entering site have a valid ID that authorizes them to be onsite.
      b. Direct all contractors and employees that do not have an identification badge to the proper location to obtain a badge before they are granted access to the site. (CM/GC trailer or turnstiles)

c. Confirm visitors by checking the CM/GC visitor list prior to issuing badge and arrange for the contact person to escort the visitor on site.
d. Maintain visitor badge log/audit of visitor badges
e. Acknowledge all incoming/outbound traffic, and ensure that all badges through the gate are scanned properly.
f. Record and report any incidents that may occur to the Site Supervisor and/or Construction Security Manager (CSM)
g. Redirect unauthorized person(s) or vehicles, and keep an accurate log of incidents.

C. Exterior/Mobile Patrol
1. Provide vehicle patrols in marked vehicles which are persistent, non-predictable, and comprehensive.
2. All Patrols SHOULD at a minimum be:
a. Inspecting fences, doors, and openings for cuts or damage to security infrastructure.
b. Checking for evidence of intrusion or tampering.
c. Identifying suspicious activity, behaviors, or packages.
d. Visually checking that individuals on site have badges clearly displayed.
e. Observe and report anything which seems out of place, and may pose a threat to safety and security.
f. Respond to Medical Emergencies and serve as the primary guide for responding to public safety.
g. Provide Escort to specific individuals or groups into sensitive areas.
h. Be able to respond to security related calls within 5 minutes.
i. Be able to respond to any life safety and security emergency calls within 2 minutes.
j. Be able to sweep entire construction site within an hour of request.

D. Badging Officer
1. A dedicated officer responsible for processing security and access permissions for employees and contractors, as well as existing personnel, visitors and others requiring building/property access. Other duties include:
a. Create badges for new employees assigned to the client and remove terminated employees from the system
b. Create detailed reports using access control software for journal reports, employee counts, active/deactivate cards, time schedules, and other complex reports.
c. Assist with review of closed circuit televisions when necessary.

E. Foot Patrol
1. Provide foot patrol functions within or nearby structures which are persistent, non-predictable, and comprehensive.
2. All Patrols SHOULD at a minimum be:
a. Checking doors and openings for cuts or damage to security infrastructure.
b. Checking for evidence of intrusion or tampering.
c. Identifying suspicious activity, behaviors, or packages.
d. Visually checking that individuals on site have badges clearly displayed.
e. Observe and report anything which seems out of place, and may pose a threat to safety and security.
f. Respond to Medical Emergencies
g. Provide Escort to specific individuals or groups into sensitive areas.
h. Be able to respond to security related calls within 5 minutes.
i. Be able to respond to any life safety and security emergency calls within 2 minutes.

j. Be able to sweep entire construction site within an hour of request.

F. Shift Supervisors
1. Utilize internal tools for reporting incidents.
2. Manage the scheduling and performance of site officers during the operational shift.
3. Escalate reportable incidents to the Security Manager and General Contractor representatives.
4. Serve in any of the operational roles as a temporary “fill in.”
5. In the absence of the CSM, perform all duties assigned to that role.

G. Turnstile
1. Officers working the turnstiles must be alert and aware of their surroundings, ensuring that electronic logs are documenting the flow of traffic both onto and off of the construction site. In addition to these, turnstile officers must:
a. Ensure all persons entering the construction site have a valid ID badge authorizing them to be on site
b. Direct all contractors and employees that do not have an identification badge to be “processed” before they may enter the construction site
c. Monitor the computer to ensure that only authorized persons are allowed to enter to site
d. Maintain an active log of temporary badges issued and conduct an audit of all badges as required
e. Assist the construction gate officer with problems or questions regarding a particular badge in addition, to deactivating badges of dismissed/banned persons/employees
f. Monitor traffic through the turnstiles to ensure no “passback” (sharing) of badges; know where the emergency shut-off breaker is during cases of site emergencies

H. LSOC Officers
1. Local Security Operations Centers may be utilized for remote monitoring of security systems, access controls, or incident investigation. Officers stationed within an LSOC are tasked with:
a. Monitoring deliveries
b. Archiving CCTV footage for safety or policy violations.
c. Utilizing access control software
d. Emergency Management or ERT members and security staff.
e. Dispatching officers to incidents.

I. Firewatch Officer
1. Depending on specific AHJ requirements, staff (such as security) may be utilized to provide fire detection duties. These include:
a. Patrolling structures to observe fire or evidence of fire.
b. Escalation to supervision and public safety.
c. Blocking access to structures in danger.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

REVISION HISTORY

Version	Date	Description and location of change
1	March 2021	Initial version
2	July 2021	Updates to 1.2 STAFFING MODEL Article and removal of references to phases in positions from this specification. See YAWN Construction Security Staffing (UID: 27250) for relevant phases for each position.
3	Sept 2022	Updated Part 0 instructions.

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.

1.3 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).

D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.

1. Mockups are used for one or more of the following:

a. Verify selections made under Sample submittals.
b. Demonstrate aesthetic effects.
c. Demonstrate the qualities of products and workmanship.
d. Demonstrate successful installation of interfaces between components and systems.
e. Perform preconstruction testing to determine system performance.

2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.

E. Fabrication Mockups: Mockups constructed off-site with final materials and construction methods. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.

F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) in accordance with 29 CFR 1910.7, by a testing agency accredited in accordance with NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."

I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect[**or Construction Manager**].

1.4 DELEGATED DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.5 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.6 ACTION SUBMITTALS

A. Mockup Shop Drawings:

1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
2. Indicate manufacturer and model number of individual components.
3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.7 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.

2. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

F. Reports: Prepare and submit certified written reports and documents as specified.

G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Start of Work, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities and to coordinate Owner's quality-assurance and quality-control activities. Coordinate with Contractor's Construction Schedule.

B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections, including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and

inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.

2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by Commissioning Authority.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports, including log of approved and rejected results. Include Work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.9 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.

5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement of whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement of whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.

1. Requirements of authorities having jurisdiction supersede requirements for specialists.

G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor's Responsibilities:

    a. Provide test specimens representative of proposed products and construction.
    b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
    d. Build site-assembled test assemblies and mockups, using installers who will perform same tasks for Project.
    e. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.

K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups of size indicated.
2. Build mockups in location indicated or, if not indicated, as directed by Architect.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
5. Demonstrate the proposed range of aesthetic effects and workmanship.

6. Obtain Architect's approval of mockups before starting corresponding Work, fabrication, or construction.

    a. Allow seven days for initial review and each re-review of each mockup.

7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
10. Demolish and remove mockups when directed unless otherwise indicated.

L. Scheduling all Mockups:

1. Include all mockups in the Construction Progress Schedule. Allow adequate time for submittals, coordination drawings, pre-installation conferences, and Owner/Architect review. Failure to schedule mockups adequately will not entitle Contractor to additional time or compensation.
2. Mockup activities may entail out-of-sequence work. No additional compensation will be made for Work related to mockups.
3. Consolidate mockup activities to allow adequate review of workmanship where dissimilar materials abut.
4. Notify Architect and Owner at least seven days in advance of date and time mockup will be erected.

M. Refer to applicable Division 02 through 49 sections for product and execution requirements related to mockups.

N. Fabrication Mockups: Where indicated in the specifications or as directed by Architect in field, construct fabrication mockups.

O. In-Place Mockups: Where indicated in the specifications or as directed by Architect in field, construct in-place mockups.

1.11 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Engage a qualified testing agency to perform quality-control services.

    a. Contractor will not employ same entity engaged by Owner, unless agreed to in writing by Owner.

3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Owner, Architect, Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Owner, Architect, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and

conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.

1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
2. Distribution: Distribute schedule to Owner, Architect, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.12 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified testing agency or special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect, Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.

3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect and Commissioning Authority with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's, Commissioning Authority's, and authorities' having jurisdiction reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms, including "requested," "authorized," "selected," "required," and "permitted," have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms, including "shown," "noted," "scheduled," and "specified," have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.3 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations, List: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. Abbreviations and acronyms not included in this list are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States." The information in this list is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; (see FGIA).
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute; www.concrete.org.
9. ACP - American Clean Power; (Formerly: American Wind Energy Association); www.cleanpower.org.
10. ACPA - American Concrete Pipe Association; www.concretepipe.org.
11. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
12. AF&PA - American Forest & Paper Association; www.afandpa.org.
13. AGA - American Gas Association; www.aga.org.
14. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
15. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
16. AI - Asphalt Institute; www.asphaltinstitute.org.
17. AIA - American Institute of Architects (The); www.aia.org.
18. AISC - American Institute of Steel Construction; www.aisc.org.
19. AISI - American Iron and Steel Institute; www.steel.org.
20. AITC - American Institute of Timber Construction; (see PLIB).
21. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
22. AMPP - Association for Materials Protection and Performance; www.ampp.org.
23. ANSI - American National Standards Institute; www.ansi.org.
24. AOSA/SCST - Association of Official Seed Analysts (The)/Society of Commercial Seed Technologists (The); www.analyzeseeds.com.

25. APA - APA - The Engineered Wood Association; www.apawood.org.
26. APA - Architectural Precast Association; www.archprecast.org.
27. API - American Petroleum Institute; www.api.org.
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASA - Acoustical Society of America; www.acousticalsociety.org.
30. ASCE - American Society of Civil Engineers; www.asce.org.
31. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (see ASCE).
32. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
33. ASME - ASME International; American Society of Mechanical Engineers (The); www.asme.org.
34. ASSE - ASSE International; (American Society of Sanitary Engineering); www.asse-plumbing.org.
35. ASSP - American Society of Safety Professionals; www.assp.org.
36. ASTM - ASTM International; www.astm.org.
37. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
38. AVIXA - Audiovisual and Integrated Experience Association; www.avixa.org.
39. AWI - Architectural Woodwork Institute; www.awinet.org.
40. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
41. AWPA - American Wood Protection Association; www.awpa.com.
42. AWS - American Welding Society; www.aws.org.
43. AWWA - American Water Works Association; www.awwa.org.
44. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
45. BIA - Brick Industry Association (The); www.gobrick.com.
46. BICSI - BICSI, Inc.; www.bicsi.org.
47. BIFMA - Business and Institutional Furniture Manufacturer's Association; www.bifma.org.
48. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
49. BWF - Badminton World Federation; www.bwfbadminton.com.
50. CARB - California Air Resources Board; www.arb.ca.gov.
51. CDA - Copper Development Association Inc.; www.copper.org.
52. CE - Conformite Europeenne (European Commission); www.ec.europa.eu/growth/single-market/ce-marking.
53. CEA - Canadian Electricity Association; www.electricity.ca.
54. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
55. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
56. CGA - Compressed Gas Association; www.cganet.com.
57. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
58. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
59. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
60. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
61. CPA - Composite Panel Association; www.compositepanel.org.
62. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
63. CRRC - Cool Roof Rating Council; www.coolroofs.org.
64. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
65. CSA - CSA Group; www.csagroup.org.
66. CSI - Cast Stone Institute; www.caststone.org.
67. CSI - Construction Specifications Institute (The); www.csiresources.org.

68. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
69. CTA - Consumer Technology Association; www.cta.tech.
70. CTI - Cooling Technology Institute; www.coolingtechnology.org.
71. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
72. DHA - Decorative Hardwoods Association; www.decorativehardwoods.org.
73. DHI - Door and Hardware Institute; www.dhi.org.
74. ECIA - Electronic Components Industry Association; www.ecianow.org.
75. EIMA - EIFS Industry Members Association; www.eima.com.
76. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
77. EOS/ESD - EOS/ESD Association, Inc.; Electrostatic Discharge Association; www.esda.org.
78. ESTA - Entertainment Services and Technology Association; www.esta.org.
79. EVO - Efficiency Valuation Organization; www.evo-world.org.
80. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
81. FGIA - Fenestration and Glazing Industry Alliance; https://fgiaonline.org.
82. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
83. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
84. FM Approvals - FM Approvals LLC; www.fmapprovals.com.
85. FM Global - FM Global; www.fmglobal.com.
86. FRSA - Florida Roofing and Sheet Metal Contractors Association, Inc.; www.floridaroof.com.
87. FSA - Fluid Sealing Association; www.fluidsealing.com.
88. FSC - Forest Stewardship Council U.S.; www.fscus.org.
89. GA - Gypsum Association; www.gypsum.org.
90. GS - Green Seal; www.greenseal.org.
91. HI - Hydraulic Institute; www.pumps.org.
92. HMMA - Hollow Metal Manufacturers Association; (see NAAMM).
93. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
94. IAS - International Accreditation Service; www.iasonline.org.
95. ICC - International Code Council; www.iccsafe.org.
96. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
97. ICPA - International Cast Polymer Association (The); www.theicpa.com.
98. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
99. IEC - International Electrotechnical Commission; www.iec.ch.
100. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
101. IES - Illuminating Engineering Society; www.ies.org.
102. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
103. IGMA - Insulating Glass Manufacturers Alliance; (see FGIA).
104. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.org.
105. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
106. Intertek - Intertek Group; www.intertek.com.
107. ISA - International Society of Automation (The); www.isa.org.
108. ISFA - International Surface Fabricators Association; www.isfanow.org.
109. ISO - International Organization for Standardization; www.iso.org.
110. ITU - International Telecommunication Union; www.itu.int.
111. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
112. LPI - Lightning Protection Institute; www.lightning.org.
113. MBMA - Metal Building Manufacturers Association; www.mbma.com.

114. MCA - Metal Construction Association; www.metalconstruction.org.
115. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
116. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
117. MHI - Material Handling Industry; www.mhi.org.
118. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
119. MPI - Master Painters Institute; www.paintinfo.com.
120. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry, Inc.; www.msshq.org.
121. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
122. NACE - NACE International; (National Association of Corrosion Engineers International); (see AMPP).
123. NADCA - National Air Duct Cleaners Association; www.nadca.com.
124. NAIMA - North American Insulation Manufacturers Association; www.insulationinstitute.org.
125. NALP - National Association of Landscape Professionals; www.landscapeprofessionals.org.
126. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
127. NBI - New Buildings Institute; www.newbuildings.org.
128. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
129. NCMA - National Concrete Masonry Association; www.ncma.org.
130. NEBB - National Environmental Balancing Bureau; www.nebb.org.
131. NECA - National Electrical Contractors Association; www.necanet.org.
132. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
133. NEMA - National Electrical Manufacturers Association; www.nema.org.
134. NETA - InterNational Electrical Testing Association; www.netaworld.org.
135. NFHS - National Federation of State High School Associations; www.nfhs.org.
136. NFPA - National Fire Protection Association; www.nfpa.org.
137. NFPA - NFPA International; (see NFPA).
138. NFRC - National Fenestration Rating Council; www.nfrc.org.
139. NGA - National Glass Association; www.glass.org.
140. NHLA - National Hardwood Lumber Association; www.nhla.com.
141. NLGA - National Lumber Grades Authority; www.nlga.org.
142. NOFMA - National Oak Flooring Manufacturers Association; (see NWFA).
143. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
144. NRCA - National Roofing Contractors Association; www.nrca.net.
145. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
146. NSF - NSF International; www.nsf.org.
147. NSI - Natural Stone Institute; www.naturalstoneinstitute.org.
148. NSPE - National Society of Professional Engineers; www.nspe.org.
149. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
150. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
151. NWFA - National Wood Flooring Association; www.nwfa.org.
152. NWRA - National Waste & Recycling Association; www.wasterecycling.org.
153. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
154. PDI - Plumbing & Drainage Institute; www.pdionline.org.
155. PLASA - PLASA; www.plasa.org.
156. PLIB - Pacific Lumber Inspection Bureau; www.plib.org.
157. PVCPA - Uni-Bell PVC Pipe Association; www.uni-bell.org.
158. RCSC - Research Council on Structural Connections; www.boltcouncil.org.

159. RFCI - Resilient Floor Covering Institute; www.rfci.com.
160. RIS - Redwood Inspection Service; (see WWPA).
161. SAE - SAE International; www.sae.org.
162. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
163. SDI - Steel Deck Institute; www.sdi.org.
164. SDI - Steel Door Institute; www.steeldoor.org.
165. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
166. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (see ASCE).
167. SIA - Security Industry Association; www.securityindustry.org.
168. SJI - Steel Joist Institute; www.steeljoist.org.
169. SMA - Screen Manufacturers Association; www.smainfo.org.
170. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
171. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
172. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
173. SPIB - Southern Pine Inspection Bureau; www.spib.org.
174. SPRI - Single Ply Roofing Industry; www.spri.org.
175. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
176. SSINA - Specialty Steel Industry of North America; www.ssina.com.
177. SSPC - SSPC: The Society for Protective Coatings; (see AMPP).
178. STI/SPFA - Steel Tank Institute/Steel Plate Fabricators Association; www.steeltank.com.
179. SWI - Steel Window Institute; www.steelwindows.com.
180. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
181. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
182. TCNA - Tile Council of North America, Inc.; www.tcnatile.com.
183. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.kbcdco.tema.org.
184. TIA - Telecommunications Industry Association (The); www.tiaonline.org.
185. TMS - The Masonry Society; www.masonrysociety.org.
186. TPI - Truss Plate Institute; www.tpinst.org.
187. TPI - Turfgrass Producers International; www.turfgrasssod.org.
188. TRI - Tile Roofing Industry Alliance; www.tileroofing.org.
189. UL - Underwriters Laboratories Inc.; www.ul.org.
190. UL LLC - UL LLC; www.ul.com.
191. USAV - USA Volleyball; www.usavolleyball.org.
192. USGBC - U.S. Green Building Council; www.usgbc.org.
193. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
194. WA - Wallcoverings Association; www.wallcoverings.org.
195. WCLIB - West Coast Lumber Inspection Bureau; (see PLIB).
196. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
197. WDMA - Window & Door Manufacturers Association; www.wdma.com.
198. WI - Woodwork Institute; www.woodworkinstitute.com.
199. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
200. WWPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. DIN - Deutsches Institut fur Normung e.V.; www.din.de.

2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC - International Code Council; www.iccsafe.org.
4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. CPSC - U.S. Consumer Product Safety Commission; www.cpsc.gov.
2. DOC - U.S. Department of Commerce; www.commerce.gov.
3. DOD - U.S. Department of Defense; www.defense.gov.
4. DOE - U.S. Department of Energy; www.energy.gov.
5. DOJ - U.S. Department of Justice; www.ojp.usdoj.gov
6. DOS - U.S. Department of State; www.state.gov.
7. EPA - United States Environmental Protection Agency; www.epa.gov.
8. FAA - Federal Aviation Administration; www.faa.gov.
9. GPO - U.S. Government Publishing Office; www.gpo.gov.
10. GSA - U.S. General Services Administration; www.gsa.gov.
11. HUD - U.S. Department of Housing and Urban Development; www.hud.gov.
12. LBNL - Lawrence Berkeley National Laboratory; Energy Technologies Area; www.lbl.gov/.
13. NIST - National Institute of Standards and Technology; www.nist.gov.
14. OSHA - Occupational Safety & Health Administration; www.osha.gov.
15. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
16. USACE - U.S. Army Corps of Engineers; www.usace.army.mil.
17. USDA - U.S. Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
18. USDA - U.S. Department of Agriculture; Rural Utilities Service; www.usda.gov.
19. USP - U.S. Pharmacopeial Convention; www.usp.org.
20. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from U.S. Government Publishing Office; www.govinfo.gov.
2. DOD - U.S. Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.
3. DSCC - Defense Supply Center Columbus; (see FS).
4. FED-STD - Federal Standard; (see FS).
5. FS - Federal Specification; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.

    a. Available from Defense Standardization Program; www.dsp.dla.mil.
    b. Available from U.S. General Services Administration; www.gsa.gov.

c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.

6. MILSPEC - Military Specification and Standards; (see DOD).
7. USAB - United States Access Board; www.access-board.gov.
8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (see USAB).

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. BEARHFTI; California Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; (see BHGS).
2. BHGS; State of California Bureau of Household Goods and Services; (Formerly: California Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation); www.bhgs.dca.ca.gov.
3. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.oal.ca.gov/publications/ccr/.
4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHLB/IAQ/Pages/Main-Page.aspx.
5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
7. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; https://tfsweb.tamu.edu/.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 014554 – BUILDING ENVELOPE AIR BARRIER TESTING PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Administrative and procedural requirements for air leakage testing of building envelope including:

1. Building envelope pressurization and depressurization testing.
2. Infrared thermography testing.

1.3 REFERENCES

A. Air Barrier Association of America (ABAA): http://www.airbarrier.org/

B. American Society for Non-Destructive Testing (ANST): https://www.asnt.org/

C. ASTM International (ASTM): http://www.astm.org/

1. ASTM C1060 - Standard Practice for Thermographic Inspection of Insulation
2. Installations in Envelope Cavities of Frame Buildings
3. ASTM E779 - Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
4. ASTM E1186 - Standard Practices for Air Leakage Site Detection in Building
5. Envelopes and Air Barrier Systems
6. ASTM E1827 - Standard Test Methods for Determining Airtightness of
7. Buildings Using an Orifice Blower Door

D. National Environmental Balancing Bureau (NEBB): http://www.nebb.org

1. NEBB - Procedural Standards for Building Enclosure Testing (First Edition – 2013)

E. Building Code Editions: Refer to Drawing CP0-0 Code Summary.

1.4 DEFINITIONS

A. Air Barrier Accessory: Products designated to maintain air tightness between air barrier materials, air barrier assemblies, and air barrier components. Includes sealants, tapes, backer rods, transition membranes, nails/washers, ties, clips, staples, strapping, and primers.

B. Air Barrier Material: Primary element that provides designated plane of reduced air flow between different environments.

C. Air Barrier Assembly: Combination of air barrier materials and air barrier components designed to provide a designated plane of reduced air flow between environmental separators at portions of building envelope system.

D. Air Barrier Component: Pre-manufactured elements including windows, doors, and service elements installed in an environmental separator.

E. Air Barrier System: Combinations of air barrier assemblies providing designated planes of reduced air flow between different environments of a building envelope system.

F. Environmental Separator: Portions of building envelope that separates controlled interior environments from uncontrolled exterior environmental separators and areas of separation between spaces within building that have dissimilar environments.

G. Air Leakage Rate: Rate of air flow in liters per second (L/s), per unit area in square meters (m2), per unit of static pressure differential in pascals (Pa).

H. Air Permeance Rating: Quantitative measure of air diffusion through set surface area of material within a given time period under pressure differential between two sides of a material (in liters per second per square meter).

I. Building Envelope and Building Enclosure: These have essentially the same meaning and apply specifically to a continuous boundary or barrier, including perimeter floor, wall, and roof assemblies, separating interior building environmental conditions from surrounding outside/exterior environment.

J. Building Envelope/Enclosure System and Environmental Separator Locations: As defined on Drawings by continuous dashed line showing location of continuous, unbroken air barrier system surface area, including floors, walls/fenestrations, roof/ceiling areas, and multiple zones at interior functional air barrier enclosures.

K. Water Vapor Permeability: Coefficient of permeance to unit film thickness. Do not use except where film thickness is known and material is homogeneous.

L. Water Vapor Permeance: Ratio of unit water vapor transmission ratio (WVTR) to vapor pressure between two parallel surfaces of a flat material of known thickness.

M. Water Vapor Transmission Rate (WVTR): Steady water vapor flow in unit time through unit area of between specific parallel surfaces of a material, under specific conditions of temperature and humidity at each surface.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Cooperate with testing and inspection agencies employed by Owner.
2. Prepare building for testing and maintain testing conditions until testing completion including.
3. Notify testing agency minimum one week prior to testing to allow time for assignment of personnel and scheduling of tests following installation of airtight transitions between air barrier wall assemblies, air barrier wall components, and roofing assemblies.
4. Reimburse Owner or Inspection Agency where, without notification to testing agency, conditions are unsuitable or unavailable for scheduled testing and testing agency personnel made arrangements and arrived on site.

B. Preinstallation Meeting:

1. Attendance: Contractor, Installer, Owner, Architect, air barrier manufacturer's representative, designated testing agency, installers representing related work, and those requested to attend.
2. Meeting Time: Minimum three weeks prior to prior to beginning work of this Section and work of related Sections affecting work of this Section.
3. Location: Project Site.
4. Agenda:

    a. Attendance at air barrier mock-ups.
    b. Responsibilities at transitions between air barrier assemblies and components.
    c. Procedures for preparation and conducting air leakage testing.
    d. Orifice blower door pressurization and thermal testing.
    e. Closing and sealing of windows, doors, ducts, plenums, and building areas of separation.

C. Sequencing and Scheduling:

D. 1. Sequence, and schedule construction activities to allow testing and inspections to proceed without interruption or conditions resulting in inconclusive results.

    a. Arrange time period for conducting air barrier testing after penetrations of air barrier system are complete and prior to covering and becoming inaccessible due to subsequent construction.
    b. Close building access to non-testing personnel and suspend construction activities to allow unimpeded air leakage testing.

1.6 QUALITY ASSURANCE

A. Air Barrier Testing Agency: Employed by Owner to perform testing and investigations of whole building envelope prior to closing off access to completed building air barrier system.

1. Specializing in work of this Section. Able to show minimum two years' experience testing to determine air leakage of air barrier assembly.

2. NEBB Certified.
3. Employing qualified personnel to perform testing and inspections required under work of this Section.

    a. Continuous Air Barrier Pressure Testing Personnel: Able to document minimum two years of experience testing to ASTM E779 or ASTM E1827.
    b. Infrared Thermographer: ANST Level II Certified to perform infrared diagnostic evaluation or documented minimum 2 years' experience performing building infrared thermography equivalent in scope and quality as specified by this Section.

1.7 SUBMITTALS

A. Qualification Data: Testing Agency and testing personnel qualifications conforming to or exceeding specified qualifications.

B. Testing Plan and Procedures: Testing plan and procedures. Include a complete set of report forms and sample documentation conforming to ASTM E779 or ASTM E1827 procedures.

C. Test Report: Indicate a pass or fail test result. Include testing calculation of air leakage using air flow measurements, tracer gas detection, thermal images, and other tests documenting locations and types of air leakage.

1.8 CLOSEOUT SUBMITTALS

A. Record Documentation: Maintain copies of inspections, testing, and laboratory reports at Project Site as Project Record Documents and submit to Owner and authorities having jurisdiction.

1.9 FIELD CONDITIONS

A. Ambient Conditions: Perform testing during conditions of calm winds, moderate temperatures, and low exposure to direct solar radiation as necessary to increase precision of test results.

1. Wind Velocity: Maximum 15 mph (6.7 m/s).
2. Temperature Difference: Minimum 10 degrees F (7.8 degrees C) between average exterior and interior building temperatures.
3. Solar Radiation: Do not conduct thermal imaging testing of surfaces exposed to direct sunlight. Consider testing after sunset or prior to sunrise.
4. Do not test in conditions where pressure gradients at building envelop caused by interior/exterior temperature differences, wind speed, and solar exposure are impractical for obtaining precise test results.

B. Temperature Factor due to Stack Effect:

1. Determine influence on building enclosure pressure due to building height and temperature factor.

2. Consider conducting orifice blower door test to ASTM E1827 where indoor/outdoor air temperature difference multiplied by building height exceeds a temperature factor of 2,360-foot degrees F (400 m degrees C).

PART 2 - PRODUCTS

2.1 TESTING AGENCIES

A. To be determined.

2.2 REGULATORY REQUIREMENTS

A. Refer to Drawing CP0-0 Code Summary.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify conditions as satisfactory to receive work of this Section before beginning.

B. Verify that continuous air barrier system at building envelope is complete and building is ready for air leakage testing procedures.

3.2 PREPARATION

A. Intentional Exterior Air Barrier Penetrations: Seal intentional openings and penetrations of building envelope using air-tight films, by closing dampers in locked position, and by using means necessary to limit testing results to that of exterior air barrier system. Include:

1. Air intake and exhaust louvers.
2. Make-up air intakes.
3. Pressure relief dampers and louvers.
4. Dryer and exhaust vent dampers.

B. Exterior Windows and Doors (Fenestrations): Close and lock. Do not seal using additional means of isolation.

C. Plumbing Traps: Fill with water.

D. HVAC System and Combustion Equipment: Shut down or disable for duration of test. Place combustion equipment in pilot position.

E. Interior Doors and Other Fenestrations: Secure in open position during testing for each zone.

1. Exceptions:

a. Interior doors that access interior spaces within a single zone may remain closed as long as an air barrier boundary separates tested zone from other zones not being tested.
b. Where doorways cannot be opened, measure pressure, using an under-door probe, to verify that room on other side of door is within 10 percent of average building pressure when orifice blower door fan is in operation.

F. Buildings with Dropped Ceiling Plenums: Remove ceiling panels at rate of one at each 500 square foot area.

1. Inspect for potential air leakage from dropped ceilings, plenums, and seal sources of air leakage into tested zone from other zones.
2. Remove additional ceiling panels at discretion of testing agency as necessary to achieve uniform pressure distribution within plenum space.
3. When conducting thermal imaging, where practical, test prior to ceiling panel installation.

G. Building Access: Prevent non-testing personnel access to and from building during testing.

H. Building Test Conditions: Do not alter during testing.

3.3 AIR LEAKAGE TESTING

A. Conform to NEBB Procedural Standards and requirements of Energy Code referenced on Drawing CP0-0 Code Summary.

B. Fan Pressurization or Orifice Blower Door Testing:

1. Conduct in conformance to ASTM E779 or ASTM E1827.
2. Where exceeding 0.40 cfm/sf at 1.57 psf pressure differential at 75 Pascals (0.3 in H2O).

C. Infrared Thermography Testing: Determine air leakage pathways in conformance to ASTM E1186.

1. Inspect completed building using infrared cameras with a resolution of 32 degrees F (0.1 degree C) or better.
2. Determine air leakage pathways.
3. Perform infrared scans by a Level II Thermographer or higher.

D. Smoke Tracer Practice: Conform to provisions of ASTM E1186 for detection of air leakage.

E. Compile and submit report to authorities having jurisdiction prior to obtaining occupancy permit.

3.4 ADJUSTING

A. Repair or replace defective air barrier assemblies and components not conforming failing to pass testing specified by this Section.

1. Review remedies for defects with Architect.
2. Do not proceed until acceptance by Architect.
3. Retest air barrier system as necessary to pass air barrier testing procedures.
4. Compensate testing agency on time and expense basis at customary hourly rate for retesting.

B. Where allowed by code and repair or replacement of defective work is impractical, Owner has prerogative to direct an appropriate remedy or to adjust payment of Contract Sum.

END OF SECTION 014554

SECTION 015000
TEMPORARY FACILITIES AND CONTROLS

TABLE OF CONTENTS

PART 0 PROJECT-SPECIFIC AMENDMENTS
PART 1 GENERAL
- 1.1 SUMMARY
- 1.2 GENERAL REQUIREMENTS
- 1.3 RELATED REQUIREMENTS
- 1.4 REFERENCE STANDARDS
- 1.5 SCHEDULED USES
- 1.6 CONDITIONS OF USE
- 1.7 SUBMITTALS
- 1.8 QUALITY ASSURANCE

PART 2 PRODUCTS
- 2.1 PRODUCTS AND EQUIPMENT, GENERAL
- 2.2 CONTRACTOR'S TEMPORARY FACILITIES
- 2.3 INSTALLATION OF GENERAL SERVICE FACILITIES
- 2.4 TEMPORARY SITE OFFICES
- 2.5 SIGNAGE
- 2.6 STORAGE/PREFABRICATION AREAS
- 2.7 CHUTES, LIFTS, SCAFFOLDS, AND HOISTING EQUIPMENT
- 2.8 CONSTRUCTION WATER SERVICES
- 2.9 POWER
- 2.10 HEATING DEVICES
- 2.11 LIGHTING
- 2.12 ELECTRICAL SERVICE
- 2.13 WASTE MANAGEMENT
- 2.14 SITE SECURITY REQUIREMENTS
- 2.15 FIRE PROTECTION
- 2.16 SANITARY FACILITIES
- 2.17 MISCELLANEOUS GENERAL SERVICES

PART 3 EXECUTION
- 3.1 INSTALLATION
- 3.2 OPERATIONS
- 3.3 TERMINATION AND REMOVAL
- 3.4 RESPONSIBILITY SCHEDULE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for temporary facilities and controls.
   1. Temporary site offices.
   2. Signage.
   3. Storage.
   4. Chutes, lifts, scaffolds, and hoisting equipment.
   5. Construction water service.
   6. Power.
   7. Heating devices.
   8. Lighting devices
   9. Electrical power access and distribution.
   10. Waste management.
   11. Site security.
   12. Sanitary Facilities.
   13. Miscellaneous General Services.

1.2 GENERAL REQUIREMENTS

B. Contractor shall be responsible for providing and maintaining the necessary construction facilities including field offices, material storage, access entrances and roads, and sanitary facilities necessary for Contractor’s, Owner’s, and by pre-arrangement between Contractor and Owner, subcontractor’s use at Contractor's expense except as noted in this Section.

C. Contractor shall provide construction facilities as needed for its construction activities, and shall accommodate other necessary activities at the site. Providing adequate general services is Contractor's responsibility, and is not limited to the minimums established in this Section. Except as otherwise indicated, the use of alternative general services equivalent to those specified is at Contractor's option, subject to acceptance by Owner. Temporary general services exclude inspection and testing services, surveys, photographs, security provisions, protection, safety, final cleaning, start-up of systems, instructions to Owner personnel and other services which are recognized to be similar to the work of this Section but are specified in other Sections.
   1. Refer to Contract Documents for locations of Contractor Temporary Facilities.

D. Contractor shall not use existing campus facilities such as restrooms, lunchrooms, or other such Owner facilities.

E. Location and extent of construction logistics provisions: A/E of Record will determine the final location of the construction logistics area, including laydown, temporary construction conditions and facilities, and other required onsite areas as provided in the approved campus plan. A/E of Record will include applicable jurisdictional compliance in its IFC design.

F. Design of grading and utility provisions: IFC documents issued to Contractor (at Mass Grading, PUF, BOP or other project phase) will include mass grading of construction logistics area, and provide for surface drainage that integrates with the overall campus plan. Design and permitting of services from connection to public utilities to the logistics area, fine grading,

hardscape, and distribution of utilities shall be the responsibility of Contractor. Routing of utility services from the point of connection to the logistics area is subject to Owner approval.

G. Layout of construction logistics provisions identified after issuance of IFC documents: Contractor shall be responsible for any ancillary designs beyond the scope addressed in the campus plan, provided that such ancillary areas shall be contained within the construction logistics area identified on the IFC documents, and are approved by Owner. Contractor shall obtain required permits for post-IFC logistics installations from jurisdictional authorities at any government level.

1.3 RELATED REQUIREMENTS

H. Section 013300 - Submittal Procedures

I. Section 013553 - Construction Security Requirements (YAWN)

J. Section 014000 - Quality Requirements

K. Section 015110 - Site Temporary Power Requirements

L. Section 016000 - Product Requirements

M. Section 017300 - Execution

1.4 REFERENCE STANDARDS

N. Referenced standards shall be the latest editions adopted as of the project bid date, except that if an earlier edition is cited in a code or law adopted by the local AHJ, that edition shall take precedence.

O. National Fire Protection Association (NFPA):
1. NFPA 10 - Standard for Portable Fire Extinguishers.
2. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.

P. United Nations Economic Commission for Europe (UNECE):
1. GHS - Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

1.5 SCHEDULED USES

Q. Provide temporary general services when first needed at the site; maintain, expand, and modify the facilities as needed throughout the construction period.

1.6 CONDITIONS OF USE

R. Operate, maintain, control and protect general service facilities in a manner which will prevent fire, hazardous exposures, public health risks, unsanitary conditions, pollution, contamination,

discomfort to users, flooding, interference with the construction work, public nuisances and similar deleterious effects.

1.7 SUBMITTALS

S. Comply with the requirements of Section 013300 - Submittal Procedures.

T. Submit copies of inspection reports, certificates, permits and similar documentation required or issued in connection with general services.

U. Scheduling: Schedule dates for delivery, setup, use, and removal of temporary facilities. Coordinate with the Construction Schedule.

1.8 QUALITY ASSURANCE

V. Regulatory Requirements
1. Comply with applicable requirements of authorities having jurisdiction regarding public health and safety during the construction period.
2. Apply, arrange, and pay for permits, tests, and inspections related to the Work of this Section as required by authorities having jurisdiction.
3. Comply with the requirements of Section 014000 - Quality Requirements.

W. Responsibilities
1. Except as otherwise indicated, the assignment of responsibilities for installing facilities and performing general services, and for complying with trade regulations and union jurisdictions associated therewith, is Contractor's obligation.

X. Special Project Requirements
1. Temporary power, temporary heating/cooling, and protection of permanently installed equipment.

PART 2 - PRODUCTS

2.1 PRODUCTS AND EQUIPMENT, GENERAL

Y. Comply with Section 016000 - Product Requirements.

Z. General
1. Unless otherwise specified, Contractor may provide either new or used materials and equipment for general service facilities, which are in substantially undamaged condition, without significant deterioration, and which are recognized in the construction industry by compliance with standards appropriate to AHJ, as being suitable for the intended use in each application.
2. Any second hand equipment put to use must not present a risk to the health and safety of users or occupants and where appropriate, be tested to a recognized standard (that is, electrical or wiring systems, air conditioning and heating, temporary power, and related

services) and certified as safe before first use in accordance with accepted local standards.

AA. Construction Materials
1. For offices, sanitary facilities, conference facilities, storage sheds, and similar construction, provide standard-manufactured, prefabricated, or mobile facility construction, insulated and weather-tight where indicated to be heated or air conditioned, or provide equivalent job-built construction. Equip each unit with locked entrances, operable windows, roofing, adequate foundations for usual loading including wind loads, serviceable finishes of the types indicated, and mechanical/electrical equipment as needed to achieve the ambient conditions indicated.

2.2 CONTRACTOR'S TEMPORARY FACILITIES

BB. Types of temporary facilities and general services required for Contractor's project use include (but are not necessarily limited to) the following:
1. Owner field office that complies with Owner security requirements.
2. Field offices for Contractor and subcontractors.
3. On-site and offsite storage facilities and prefabrication for Contractor and subcontractors.
4. Sanitary facilities for Contractor and subcontractors.
5. Collection/disposal of waste materials.
6. Miscellaneous general services.
7. Break facilities for workforce.

CC. Self-Contained Toilet Units:
1. Portable toilets shall be single-occupant, self-contained units of the chemical aerated recirculation type fully enclosed with a glass fiber reinforced polyester shell or similar non-absorbent material, vented and maintained in operation.
2. Toilets shall be located within a five-minute walk of major work areas.
3. Separate toilet rooms for men and women shall be provided. Facilities designated for women shall have the option to secure doors.
4. There shall be an option for mobile restroom trailers, as needed.

2.3 INSTALLATION OF GENERAL SERVICE FACILITIES

DD. General:
1. The Owner has designated Contractor trailer, material storage laydown, and parking areas to be shared by multiple contractors working concurrently at the Plant as shown in the Contract Drawings. Parking on existing road shoulders, in Owner parking areas, or parking in any way that affects the Owner's ingress/egress is not permitted.
2. Locate facilities within the designated Contractor area where they will serve the total project construction work adequately, and cause minimal interference with performance of the Work. Relocate, modify and extend facilities as required within the designated area during the course of the Work, to accommodate the entire Work of the Project. Provide a reasonably neat and uniform appearance in general service facilities, acceptable to Owner's Representative.
3. Except as otherwise indicated, do not plan to change over the use of permanent facilities of the project to replace the use of temporary general service facilities. However, it is

recognized that certain general service facilities will need to be removed from the site at or near the time of field acceptance, and that Contractor's personnel remaining at the site beyond that time will be permitted to use certain permanent facilities, under restricted use conditions which are acceptable to the Owner's Representative.

4. Site logistics plans, trailer layouts, site amenities, and parking areas, shall be coordinated with the A/E of Record and are subject to final approval by Owner site team. See table "Site Logistics Plan Checklist" following.

EE. Site Logistics Plan Checklist

The site construction team shall develop the site logistics plan based on the following checklist as a minimum and review with A/E of Record and Owner for any site-specific requirements.

	Description	Drawings	Description	Remarks
		Yes / No	Yes / No	
1	Identify point-of-entrance locations and traffic routes for movement of Contractor's equipment, materials, and workers to the work locations.			
2	Incorporate escort provisions including conformance with Owner's security policies and requirements regarding allowable number and handling of unbadged personnel.			
3	Locate on plans construction zone accommodations of vehicular and aircraft traffic including signage, traffic stripping, flagging, temporary closures, barricades, and detours.			
4	Locate on plans provisions for worker parking and routes to and from the Work.			
5	Locate on plans staging/laydown areas for construction equipment, trash/debris receptacles, material storage and protection, shipping containers, and similar facilities as may be required for prosecution of the Work.			
6	Locate on plans temporary facilities including trailers, dumpsters, and sanitary facilities.			
7	Define alterations to existing facilities/infrastructure.			
8	Identify locations and related work zones for worker/material handling equipment such as cranes and lifts.			
9	Provide emergency vehicle access in accordance with requirements of local first responders.			
10	Provide emergency evacuation routes, meeting locations, and plans.			
11	Provide protection of private and public properties, including leased properties on site, if applicable.			
12	Identify security provisions, including pedestrian turnstiles, vehicular gates, and and other facilities as may be required to fulfill Contractor's site security			

	Description	Drawings	Description	Remarks
		Yes / No	Yes / No	
	obligations.			
13	Locate on plans fencing and enclosure provisions for meeting the site security requirements.			
14	Identify the location of off-site, project-related facilities.			
15	Identify on-site parking provisions if applicable.			
16	Emergency contacts must be posted on plans.			
17	Define work shifts and corresponding working hours.			
18	Show routing of temporary utility lines and points of tie-ins.			
19	Show provisions for reclamation of areas disturbed by Contractor, if applicable.			
20	Provide plans and actions taken to comply with environmental requirements and permits.			
21	Identify the means for dust/dirt/debris mitigation.			
22	Identify the means for construction noise mitigation.			
23	Incorporate coordination and accommodation of stakeholders impacted by the Work.			
24	Incorporate coordination with other contractors impacted by or impacting the Work.			
25	Identify other unique conditions applicable to the project.			
26	Identify locations of first aid kits, fire extinguishers, AEDs (automated external defibrillator), and other such emergency provisions as may be required by law or the Construction Agreement.			
27	Identify location of restrooms for workers.			
29	Location of truck-washing areas (if required).			
30	Locate on plans areas for different PPE/safety requirements, areas for different Work Notification processes, and areas for high-risk activities.			
31	Locate on plans areas for clean build protocols, document control, IT servers, printers, and related IT equipment.			
32	Location of temporary tornado shelters (site-specific, as required by site Emergency Action Plan).			
33	Where de-icing salt will be stockpiled on-site, provide protection against leaching into soil and obtain required permits from AHJ.			

2.4 TEMPORARY SITE OFFICES

FF. Provide and maintain a climate-controlled modular office, with the following minimum equipment and services:
1. Meeting table and chairs.
2. Filing cabinets.
3. Drinking water.
4. Electrical service with at least code-required minimum quantity of duplex GFCI outlets.
5. Accessible restrooms in quantity required by the local AHJ based on the office size.
6. Telephone and fax service.
7. Secure wireless Internet service.

GG. Make the office available for use by Owner and A/E of Record during working hours and for specified project meetings.

2.5 SIGNAGE

HH. Furnish and install signage at the construction entrance to provide required local, state, and federal notifications.

2.6 STORAGE/PREFABRICATION AREAS

II. Provide dry and secure storage facilities to protect stored products from damage or deterioration during construction. Comply with manufacturer’s requirements for storage conditions. Comply with Owner’s requirements and conditions for off-site storage.

JJ. Perform equipment inspection periodically according to manufacturer's recommendations to avoid any warranty issues when the equipment is installed. Note that different equipment suppliers may recommend different preservation and inspection plans, even if the product type is similar.

KK. Temporary storage tents shall be designed to withstand adverse weather conditions typical of the Project location.

LL. Gear shall follow supplier’s storage recommendations.

2.7 CHUTES, LIFTS, SCAFFOLDS, AND HOISTING EQUIPMENT

MM. It is Contractor's responsibility to verify that the job site equipment is suitable for use and meets Owner's requirements. Refer to Contract Documents for Construction Environmental Health and Safety requirements.

NN. **EMEA**: If the Contractor uses Owner equipment while in operations, during construction, additionally to what has been referred to in the works, the Owner will inform Contractor about the risks Contractor is exposed to on site.

2.8 CONSTRUCTION WATER SERVICES

OO. Provide water required for and in connection with Work to be performed and for specified tests of piping, equipment, devices, or for other use as required for completion of the Work.

2.9 POWER

PP. See Section 015110 - Site Temporary Power Requirements.

2.10 HEATING DEVICES

QQ. Temporary heating is required for freeze protection.

2.11 LIGHTING

RR. Lighting shall be adequate to prevent slips/trips/falls and to allow for work to take place safely (a minimum of 5 ft^2/candles or 54 lumens/m^2).

SS. Where lighting may spill onto adjacent property, provide fixtures with shields to confine lighting to Owner's site. Subject to Owner approval, this requirement may be waived where shields impinge on construction safety or utility.

TT. Lighting may be natural, permanent, or provided through temporary means.
1. To the extent possible, avoid using halogen lighting.
2. Where practicable, consider using temporary lighting that is solar-powered, photocell-controlled, or both.

UU. Lighting may also be provided through supplemental handheld or personal devices.

VV. Lighting within electrical or mechanical rooms shall be at minimum 10 ft^2/candles or 108 lumens/m^2.

2.12 ELECTRICAL SERVICE

WW. See Section 015110 - Site Temporary Power Requirements.

XX. Supplement electrical system as required for special work results.

2.13 WASTE MANAGEMENT

YY. Provide adequate construction waste management services for the Project. Refer to Contract Documents for Construction Environmental Health and Safety requirements.
1. Contractor shall categorize waste for management and disposal according to its waste management procedure/plan. Waste management procedures/plans must be in compliance with all applicable laws and regulations, and shall promote a safe and healthy workplace.

a. Contractor is responsible for identifying the type of waste produced during the project.
b. Contractor must evaluate the project-generated waste for its physical, chemical, and biological characteristics to determine management in accordance with applicable regulations.

ZZ. Chemical and Waste Storage:
1. Chemicals must be labeled and Chemical Information Sheet Safety Data Sheets (SDS) readily available per Global Harmonization Standard (GHS).
2. Chemicals shall be segregated appropriately, and stored and inspected in accordance with local legal requirements.
3. Waste containers shall be labeled in accordance with local regulations, directives or codes.

AAA. To the extent possible, waste shall be Prevented, Reduced, Reused, Recycled, or Recovered. Do not send waste to landfill (Dispose) unless there is no other feasible alternative, and only with Owner approval.

BBB. Comply with the Owner's sustainability requirements pertinent to construction waste management. Refer to Contract Documents for Construction Environmental Health and Safety requirements.

CCC. For guidelines for waste diversion programs, see the Owner's Representative.

DDD. Additional requirements may apply depending on site / region; Contractor shall comply with applicable DCEHS gSAFE Waste Procedures. Check with Owner EHS Team for details

EEE. Ensure all waste streams are stored, collected and disposed of in accordance with local requirements.

FFF. Maintain monthly reports for all waste volumes generated on site. These reports shall include:
1. Waste material: plastic, metal, wood, and other industry-standard waste categories.
2. Waste volume per type: in kg or lb depending on location.
3. Disposal method for each removed waste following Waste Management Hierarchy: Prevent, Reduce, Reuse, Recycle, Recover, Dispose.

2.14 SITE SECURITY REQUIREMENTS

GGG. Construction Site Security: For security requirements associated with securing and protecting the site, see Section 013553 - Construction Security Requirements (YAWN).

2.15 FIRE PROTECTION

HHH. Install and maintain temporary portable fire extinguishers to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10 and NFPA 241.

III. Provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for exposures for general

building fire protection. Fire extinguishers shall be located where convenient and effective for their intended purpose, with not less than one extinguisher on each floor at or near each usable stairwell.

JJJ. Contractor shall support and be responsible for fire safety. In particular, Contractor shall observe the following:
1. Store flammable and combustible liquids in approved, maintained and labeled containers in fire-safe locations.
2. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, and stairways and other access routes for fighting fires
3. Prohibit smoking inside the project building or facility, and within other hazardous fire exposure areas.

2.16 SANITARY FACILITIES

KKK. General:
1. Sanitary facilities include toilets, wash facilities, drinking water fixtures and food/beverage service facilities (if any). Comply with governing regulations including safety and health codes for the type, number, location, operation, and maintenance of fixtures and facilities, but provide not less than the specified requirements. Install sanitary facilities in available locations which will best serve the needs of personnel at the project site.
2. Camera coverage shall be installed for monitoring of portable toilets, as coordinated by the Contractor and Owner.
3. Distribute toilets and drinking water fixtures as necessary. Plant washroom, toilet, and drinking water facilities shall not be used by Contractor or subcontractor personnel.
4. Supply and maintain toilet tissue, paper towels, paper cups and similar disposable materials as appropriate for each sanitary facility, and provide waste paper containers for used materials.
5. Toilets: Self-contained toilet units or water/sewer connected temporary toilet installations (or both) are Contractor's only option to the extent permitted by governing regulations.
6. Site shall have climate-controlled flushable restroom trailers along with portable toilets.
7. Sanitary facilities can be portable outdoor units.

LLL. Drinking Water Fixtures: Supply drinking water for construction personnel by containerized tap dispensers with paper cups.

2.17 TEMPORARY ENTRANCES AND ACCESS ROADS

MMM. Provide construction entrances and gates, and construction access roads, as needed to perform the Work of this Contract, at locations subject to Owner approval.
1. Construct temporary entrances and roads in accordance with requirements of the AHJ.
2. Where required, obtain construction and operating permits from local authorities.

NNN. Construct and maintain entrances, gates, and access roads in a manner that will not increase erosion, sedimentation, or flooding of Project site or adjacent property, including public property

2.18 MISCELLANEOUS GENERAL SERVICES

OOO. Include whatever general services may be required, or are found to be necessary, for the accommodation of the Work. Items of general service which may be needed include, but are not necessarily limited to, the installation of postal delivery service, parking spaces at the temporary offices, walkways in and around the construction area, and personal protection items for employees and visitors.

PART 3 - EXECUTION

3.1 INSTALLATION

PPP. General: Comply with requirements of Section 017300 - Execution.

QQQ. Install temporary facilities and controls in locations indicated. Maintain during the construction period to achieve work results indicated in the Contract Drawings.

3.2 OPERATIONS

RRR. Supervision:
1. Enforce strict discipline in the use of general services at the project site. Limit availability of facilities to essential and intended uses, so as to minimize wastes and the possibility of abuses and the resulting unsanitary and hazardous or dangerous conditions. Do not allow temporary offices and similar temporary or permanent spaces to be used as living quarters, or for other unintended occupancies or uses.

SSS. Janitorial Services:
1. Provide daily janitorial services for temporary offices, toilets, wash facilities, and similar areas at the project site. Require users of other general services to maintain clean and orderly premises.

TTT. Maintenance:
1. Maintain general services in good operating condition through the time of use, and until removal is authorized. Protect from damage by weather.

3.3 TERMINATION AND REMOVAL

UUU. Remove temporary facilities and controls when they are no longer required for construction operations unless extended service is requested by Owner.

VVV. Restore areas of the site that have been affected by temporary facilities and controls installation and use.

WWW. Except as otherwise indicated, the materials and equipment of temporary general services remain the property of Contractor. Owner reserves the right to take possession of project identification signs.

3.4 RESPONSIBILITY SCHEDULE

XXX. General Contractor (Lead Contractor).
1. Furnish, install, maintain, and terminate the following for use by all Contractors:
   a. Construction vehicle parking area.
   b. Material/equipment staging area.
   c. Field office in an approved area inside the existing facility.
   d. Cost of temporary electrical power consumption.
   e. Cost of temporary fuel consumption.
   f. Cost of temporary water consumption.
   g. Temporary heat/humidity control during construction.
   h. Temporary toilets.
   i. Rubbish collection and removal.
   j. Environmental controls.
   k. Fire extinguishers.
   l. Signage.
2. For General Contractor's own use:
   a. Telephone service necessary for contract administration.
   b. Barricades, warning signs and lights required for prosecution of the Work.
   c. Hoses and extension cords.
   d. Hoists, ladders, and scaffolding
   e. Drinking water.
   f. Supplementary heating and lighting for special trade-related tasks.

YYY. Plumbing/Fire Protection Contractor. Furnish, install, maintain, and terminate the following:
1. Temporary connection to building water supply, termination, and removal at Project Completion.
2. For Plumbing/Fire Protection Contractor's own use:
   a. Telephone service necessary for contract administration.
   b. Barricades, warning signs, and lights required for prosecution of the Work.
   c. Hoses and extension cords.
   d. Hoists, ladders, and scaffolding.
   e. Drinking water.
   f. Supplementary heating and lighting for special trade-related tasks.

ZZZ. Mechanical Contractor. Furnish, install, maintain, and terminate the following:
1. For use by all Contractors:
   a. Evaluation of and connection to Owner's fuel source.
   b. Fuel metering equipment, and distribution devices.
2. For Mechanical Contractor's own use:
   a. Telephone service necessary for contract administration.
   b. Barricades, warning signs, and lights required for prosecution of the Work.
   c. Hoses and extension cords.
   d. Hoists, ladders, and scaffolding.
   e. Drinking water.
   f. Supplementary heating and lighting for special trade-related tasks.

AAAA. Electrical Contractor. Furnish, install, maintain, and terminate the following:
1. For use by all Contractors:

a. Evaluation of and connection to Owner's electrical power source.
b. Electrical metering equipment, and distribution devices.
c. Temporary lighting.

2. For Electrical Contractor's own use:
   a. Telephone service necessary for contract administration.
   b. Barricades, warning signs, and lights required for prosecution of the Work.
   c. Hoses and extension cords.
   d. Hoists, ladders, and scaffolding.
   e. Drinking water.
   f. Supplementary heating and lighting for special trade-related tasks.

END OF SECTION

REVISION HISTORY

Version	Date	Description and location of change
1	April 2021	Initial version.
2	August 2021	Added: ● 1.2. General Requirements ● 1.4. Scheduled Uses ● 1.5. Conditions of Use ● 1.6: B. Scheduling ● 1.7: B. Standards ● 1.7: C. Responsibilities ● 2.1: B1. Unless otherwise specified, Contractor may provide either new or used materials… ● 2.1: C. Construction Materials ● 2.2. Contractor's Temporary Facilities ● 2.3. Installation of General Service Facilities ● 2.5: Signage to provide all required local, state, and federal signs at the construction entrance. ● 2.16. Sanitary Facilities ● 2.17. Miscellaneous General Services ● 3.2. Operations ● 3.3. Termination and Removal Revised: ● 2.13. Waste Management Removed: ● 2.14. Toilets

Version	Date	Description and location of change
3	January 2023	Updated PART 0. Added 1.2:D, E, and F. Removed notes to the specifier. Updated 2.3 B (Site Logistics Plan Checklist). Added Dx-requested updates in Article 1.2. Added minor suggested edits in other articles.

SECTION 015110
SITE TEMPORARY POWER REQUIREMENTS

TABLE OF CONTENTS

PROJECT-SPECIFIC AMENDMENTS

GENERAL
- SUMMARY
- GENERAL REQUIREMENTS
- TEMPORARY POWER SERVICE
- UTILITY AND SERVICE SIZING
- MEDIUM VOLTAGE DISTRIBUTION
- LOW VOLTAGE DISTRIBUTION
- ELECTRICAL SAFETY
- EQUIPMENT PROTECTION

PRODUCTS (NOT USED)

EXECUTION (NOT USED)

PART 1 - GENERAL

1.1 SUMMARY

A. The objective of this document is to establish minimum requirements for site temporary power during construction projects.

B. This document applies to all sites and is targeted to Contractors. The target audience also includes DCS project managers, DCS electrical engineers, electrical contractors, and equipment vendors.

1.2 GENERAL REQUIREMENTS

C. Ensure the design and installation of the temporary wiring meets the requirements of the local electrical code applicable to the country and latest revision adopted by the Authority Having Jurisdiction (AHJ).

D. Prior to energization, arrange for Authority Having Jurisdiction (AHJ) and/or quality teams to inspect the temporary service.

E. Ensure a design engineer produces stamped drawings and the associated project team submits them for local permitting.

F. To ensure awareness about energized equipment and change of state for each area of the project, provide formal communication (Site Change of State Notification, for example) to all parties prior, during, and after the energization of temporary electrical equipment.

G. Develop a Utility Avoidance Policy to be used along with an excavation permit to assist with identifying all underground utilities on a layout drawing, including temporary and permanent power.

1. Note: The goal is to ensure all trades are aware of all underground utilities and to update the layout and record drawings accordingly to prevent safety and reliability issues in case striking or damaging a power line.

H. Provide all signage related to the electrical system and electrical safety in English and in the native language (Spanish, for example) of the local area.

1.3 TEMPORARY POWER SERVICE

I. Coordinate with DCID to develop a schedule that outlines the dates and durations for the installation, shutdown, and tie-ins of temporary power.

J. At the beginning of a project, assign responsibility for the setup and payment of the temporary utility power service.

1. Determine the parties responsible for the cost and procurement of the equipment, labor, tools, and materials associated with temporary power.

2. Ensure temporary power system design, long lead equipment identification, and temporary power system pricing are finalized and submitted by FGMP.

3. Note that the responsibility to manage temporary power procurement (including billing, metering, and reporting) will transition to the client prior to transitioning from the Perun Substation or utility substation to permanent power.

4. To avoid the need for temporary power generation, procure the temporary power service as early as possible in the project.

5. Ensure the temporary power procurement is cost-effective and provides the flexibility for reuse during future project phases (suitable for outdoor use with a design life of 5 years, for example).

K. Consider and discuss the possible conversion of the temporary service to a permanent one for the HUB building for new sites with both DCS and the utility provider.

1. Discuss any permanent distribution and metering equipment requirements with the DCS Team.

L. If power is anticipated to be necessary for start-up or commissioning activities prior to the permanent power availability, provide transformation to align site MV level with temporary service.

M. Ensure construction power will not be connected to the permanent metered service of an operational data center without the written authorization of the DCID organization.

N. Perform the operation and maintenance of the temporary equipment based on the intervals noted by the manufacturer and/or according to industry standards.

1. Maintain the temporary power wiring, equipment, and systems in a safe and code-compliant condition throughout the entire construction project.

a. Examples include the replacement of filters, fueling of generators, spill containment, manufacturer required maintenance, and the documentation of generator run hours, if applicable.

O. At the conclusion of the construction project, remove temporary equipment and connections with a sign-off by DCID and leave the premises and existing permanent equipment in an equivalent condition as existed prior to installing the temporary connections.

P. Note that the electrical contractor (EC) is responsible for coordinating with an engineering firm to perform a SCCAF study for the temporary power equipment installed for construction and commissioning activities to identify the arc flash hazards, protective device settings, and to confirm the equipment is properly rated for the available fault current.

1. Ensure electrical equipment purchased for temporary power is rated for the available fault current at the utility and/or generator source and confirmed by referencing the SCCAF report.

1.4 UTILITY AND SERVICE SIZING

Q. Size the temporary power service for simultaneous construction of (2) gPOR buildings at a minimum.

R. Evaluate the following equipment during the master planning phase of the project:

1. Associated CUB equipment
2. Permanent HUB load (assume 1.5 MVA)
3. Construction power and trailers
4. Commissioning (Cx) power for the DC and gCUB
5. Completion schedule for the Perun substation

S. Ensure calculated demand load takes into account the needs for equipment heating and conditioning, building temporary heating and conditioning, temporary lighting, site lighting, power for tools, and commissioning power, if necessary.

T. Size equipment based on the continuous demand factor and forecasted loading for the connected equipment.

U. In order to calculate total temporary heating requirements, obtain the submittal drawings of owner-furnished switchboards, switchgear, and generators.

V. Ensure the planning and design phases of the temporary utility power service take into account the timeline and forecasting of future project phases and buildings based on the master plan and approval of project funding.

1. Note: Due to the increased demand for construction and commissioning power, concurrent project phases will reduce the available capacity of the utility service. Separate project phases with no overlapping activities for construction and commissioning, in turn, will enable utilizing the same capacity for the utility service.

W. In order to enable accurate measurement, reporting, and assessment of the available capacity and demand, provide permanent metering or provisions to install temporary metering.

X. Prior to proceeding with the procurement of materials and installation, review the sizing of the construction power with the electrical subject matter expert from the DCID organization.

1.5 MEDIUM VOLTAGE DISTRIBUTION

Y. Verify medium voltage infrastructure follows local utility distribution voltage. Add site distribution transformers to support building and/or construction power voltage requirements.

Z. Ensure backbone for future buildings either has medium voltage distribution expansion installed from day one or enables it for future provisions that support master planned build-out of gPOR buildings.

AA. Verify medium voltage equipment is rated for the available fault current provided by the utility.

BB. Verify the medium voltage distribution system follows relevant building duct bank specification standards for strength and construction in areas where underground distribution is suitable. Include 2 inch communications conduits in each medium voltage duct bank.

1. In order to avoid contact hazard due to overhead routing, provide underground routing of HV and MV feeders for construction power from the utility and site distribution.

CC. Ensure medium voltage distribution equipment has all NEC-required protection and relevant local utility-required protection elements, such as phase loss protection.

DD. Confirm coordination of protective device settings with the utility company (supply authority).

1.6 LOW VOLTAGE DISTRIBUTION

EE. Consider conex/portable construction that provides the flexibility for relocation and reuse on future building phases.

1. Examples include skid-mounted solutions that provide panelboards, disconnects, and transformers in a combined unit with the flexibility to relocate throughout the site.

FF. Design the electrical distribution to allow connection to temporary generators in the event utility power is unavailable for short duration activities, such as commissioning.

GG. Develop and maintain accurate panel schedules that identify the source and downstream connected loads for all branch circuits to assist with LOTO activities and identification of equipment.

HH. Ensure all openings in the temporary panelboards are closed, and blank plates and proper seals are installed.

II. Provide electrical distribution and branch circuits for heating, ventilation, and cooling equipment during the construction and commissioning phases of the project.

JJ. Provide adequate lighting with local switching for safe access, egress, security, and illumination of construction activities.

KK. In order to prevent the operation of a fuse, circuit breaker, or ground-fault circuit interrupter from de-energizing the lighting circuit due to a fault or equipment overload, provide separate branch circuits for lighting and receptacle loads.

LL. In a delta-wye configuration only, provide step-up and step-down transformers for temporary equipment for connection to the temporary power system.

MM. Ensure wiring is adequately supported, secured and protected from physical damage.

1. To prevent the floor below from being obstructed and physical damage from occurring to wiring, utilize structural hangers, supports, and/or construction power trees to mount electrical conductors.

2. Provide physical protection for wiring where it is subject to abuse or damage.

NN. In order to enable proper storage and completion of the charging requirements such as float and equalization, install temporary construction power for all battery chargers.

1. Note: Enabling temporary power for battery chargers will reduce the timeframe required for commissioning activities.

OO. In order to prevent moisture build-up in windings during the installation and prior to the start of commissioning, install temporary construction power for the shore power internal to the generator enclosure to provide continuous power for the jacket and generator heaters.

1. Note: The shore power connection is required to energize battery chargers, interior lights, breaker cabinet, and belly tank level control panels (BTLCP).

1.7 ELECTRICAL SAFETY

PP. General

1. As with permanent wiring, ensure safe electrical work practices are always used when handling temporary electrical wiring and systems.

2. Ensure all the requirements are met for electrically safe work on the circuits (dead work) and for precautions and PPE for protection against shock, arc flash, and other hazards.

3. Ensure all systems and equipment have means for LOTO by including provisions to install a lock and tag.

4. Place above-ground duct bank markers every 100 feet (30.48 m).

5. Establish a controlled access zone during the transition from construction, commissioning, and permanent power, including specific electrical training and approved list required to access the area (the electrical building, Perun substation, etc.).

a. Note: Appropriate barriers and signage are required within the controlled access zones, based on the type of hazardous activity taking place (electrical testing, for example), to protect other workers who are not involved in these activities.

6. Ensure the LOTO coordinator always repeats the Live Dead Live (LDL) test for the inspection and approval of equipment during commissioning for new members who enter the barricade after the initial start of work, after extended breaks (lunch, for example), and during the change of shift.

7. Verify wiring is not run through ducting, door ways, etc.

8. Verify equipment grounding conductors are in place and equipment is properly grounded.

9. Verify overcurrent protection, conductor sizing, and grounding/earthing all comply with local codes (generally the same for temporary wiring installations as for permanent ones).

10. Ensure the following temporary panel requirements are met:

a. All breaker spaces are filled.

b. All circuits are identified.

c. Inspection stickers are placed on cover.

d. Panels are properly installed.

e. Panels are protected from all energized parts.

f. Panels are UL listed.

QQ. Temporary Wiring

Ensure the following temporary wiring installation and usage requirements are met:

1. Flexible cords or cables, such as extension cords, are NOT used to substitute for the fixed wiring on any building or structure. Furthermore, flexible cords or cables are NOT concealed behind or transitioning through temporary or permanent walls, ceilings or floors.

2. Wiring systems in ducts used for dust or flammable vapor transport or vapor removal are NOT installed.

3. Metal enclosures for conductors are metallically joined together into a continuous metallic run that provides electrical continuity.

4. Flexible cords or cables with male to male connections on both ends (suicide cord, for example) utilized as a temporary power source for construction, testing and/or commissioning are hardwired into a junction box and have a switch installed upstream to provide a disconnecting means for LOTO and control of the power source.

5. To eliminate a shock hazard, the male prongs of the flexible cords or cables are NOT exposed to the end user.

6. The equipment is hardwired in with a junction box, or a “switch” is installed upstream from where this type of cord would be installed. Using a handy box with a lockout switch is recommended. This is a sufficient disconnecting means, which the cord and plug serve.

7. Ensure modified one-line drawings are available for all temporary power solutions.

8. Ensure proper signage is posted to identify temporary power equipment and pathways.

RR. Feeders

Ensure the following requirements are met for feeders:

1. Feeders originate in an approved distribution center.

2. Conductors run as a multi-conductor cord or cable assemblies.

3. Single-insulated / open conductors are generally NOT used for temporary feeder installations. However, individual open conductors are allowed if these conductors are accessible by qualified personnel only. Cable assemblies, hard-usage cords, extra-hard usage cords, and NM cable are also allowed.

4. No feeder conductors are laid on the floor.

SS. Branch Circuits

Ensure the following requirements are met for branch circuits:

1. Branch circuits originate in an approved power outlet or panelboard. When using permanent panelboards for temporary wiring, the permanent dead front and the permanent metal panel cover are used. Conductors are a multi-conductor cord, cable assemblies or open conductors.

2. If run as open conductors, the conductors are fastened at ceiling height at least every 3.05 meter (10.0 feet), using non-conductive means.

3. No branch-circuit conductors are laid on the floor.

4. Each branch circuit that supplies receptacles or fixed equipment contains a separate equipment grounding conductor if run as open conductors.

5. Open branch-circuit conductors are generally NOT used for temporary installations. However, cable assemblies, hard-usage cords, extra-hard usage cords, and NM cables are allowed.

6. Branch circuits are NOT in direct contact with building steel; non-conductive support materials are required for insulation.

7. Branch circuits are supported at intervals to protect them from damage.

8. Receptacles on construction sites are NOT installed on branch circuits that supply temporary lighting.

TT. Conductors

Ensure the following requirements are met for conductors:

1. Neither bare conductors nor earth returns are used for the wiring of any temporary circuit.

2. A junction box is required for all splices whether the conductors are multiconductor cord or cable assemblies type. Conductors are spliced or joined with splicing devices identified for the use.

3. Strain relief is provided to prevent direct force on the connection.

4. Flexible cords and cables entering enclosures are secured to the box with fittings designed for the purpose.

5. Flexible cords and cables are protected from accidental damage that might be caused, for example, by sharp corners, projections, and doorways or other pinch points.

6. Cables, cable assemblies, and flexible cords are supported at intervals to prevent physical damage. To provide this support, using products designed not to damage the cable or cord assembly is required.

7. Wiring supports are non-conductive.

8. Supports provide strain relief for any vertically installed conductors used as suspended power sources.

UU. Disconnecting Means

Ensure the following requirements are met for disconnecting means:

1. Suitable disconnecting switches or plug connectors are installed to permit the disconnection of all ungrounded conductors of each temporary circuit.

2. Multi-wire branch circuits provide a means (at the panelboard) to simultaneously disconnect all ungrounded conductors at the power outlet or panelboard where the branch circuit originated.

3. If the multi-wire circuit uses single-pole circuit breakers, using an approved handle tie to secure the trip handles together is required.

    a. Note: Circuit breakers with their handles connected by approved handle ties are considered a single disconnecting means.

VV. Lamps for General Illumination

Ensure the following requirements are met for lamps for general illumination:

1. All lamps for general illumination are protected from accidental contact or breakage by a suitable fixture or lampholder with a guard. The fixtures are factory assembly.

2. The lamps are maintained in safe condition.

3. Missing or broken bulbs and bulb guards are replaced.

4. Brass shell, paper-lined sockets, or other metal cased sockets are NOT used unless the shell is grounded.

5. Lighting and receptacles are NOT installed on the same circuit. Lighting must be put on one circuit and receptacles on another circuit.

6. Temporary lights are NOT suspended by their electric cords, unless cords and lights are designed for this means of suspension.

WW. Temporary Wiring and GFCI or RCD

1. Ensure the following GFCI (or RCD, less than or equal to 30mA) protection requirements are met:

    a. GFCI is installed to safeguard all receptacles, equipment, and temporary conductors or power cords used in wet or damp locations, outside, or during construction-like activities (i.e. maintenance, remodeling, or repair activities involving buildings, structures, or equipment).

    b. All single-phase, 15-, 20-, and 30-ampere receptacle outlets have GFCI protection.

        1) Note: 125 V (US) and 110 V (EMEA) power supplies are used for low voltage construction power as a means of providing a safer voltage.

    c. A cord connector on an extension cord set is a receptacle outlet if the cord set is used for temporary electric power.

    d. Cord sets and devices with GFCI connected to the receptacle closest to the source of power are acceptable forms of protection.

    e. Receptacles have GFCI protection, or an “assured equipment ground conductor program” is in place. Exceptions: Single-phase, 15-, 20-, and 30-ampere receptacles.

XX. Inspections of Installed Temporary Wiring

1. Ensure temporary wiring installations are periodically inspected to verify that the wiring is in proper working order and to discover damage from construction or maintenance activities. Ensure a record or log is maintained verifying periodic (no less than monthly) temporary wiring inspection, GFCI/RCD testing, temporary lighting checks, and labeling.

2. Ensure periodic inspections include/cover:

    a. Inspecting housing, cable condition, strain reliefs, and plug attachments

    b. Inspecting cords/conductors; cords/conductors must be in good condition and show no signs of wear, defects, bulging, exposed wire, or other damage.

    c. Ensuring cords/conductors are not affixed to walls, run under doors, or run through walls, ceiling or floors

    d. Determining that daisy chaining is NOT in use

    e. Checking that all conductors have proper overcurrent breaker protection and insulators

    f. Checking that switches are labeled identifying their control and use

    g. Checking that temporary light fixtures are all guarded

    h. Assessing if any changes or additions have been made that necessitate a review of the temporary wiring and protection

    i. Maintaining a monthly inspection log sticker

j. Inspecting all GFCIs

k. Ensuring breakers are identified

l. Ensuring all openings are closed, breaker blanks, KO seals

YY. Clear-Space Requirements

Ensure the following clear-space requirements are met:

1. For the purpose of safe operation and maintenance of temporary electrical equipment, sufficient access and working space are available and maintained for all temporary electrical equipment.

2. Because temporary electrical equipment may need examination, adjustment, servicing, or maintenance while energized, a clear working space of no less than 4 ft is available on all sides of such equipment.

   a. Note: OSHA 1926.403 Table K-1 or NEC Table 110.26(A)(1) may be used to determine working clearance requirements in lieu of the 4 ft minimum clearance.

3. No clear working spaces are used for storage.

1.8 EQUIPMENT PROTECTION

ZZ. Equipment inspection upon initial receipt

1. Upon arriving at the jobsite, but before being received and off-loaded by the subcontractor, inspect the equipment with Trade Partners to verify no moisture has been introduced or damage occurred during transit from the factory to jobsite.

2. If there is any visible damage or moisture, contact vendor representatives to review the condition of the equipment and make the determination on the path forward before removing the item from the truck.

3. Document the condition of the equipment on an inspection form with the relevant Trade Partners and create an issue electronically using a tracking software (Ex. BIM 360 2.0). Document the vendor's recommended path forward and any remediation or repair necessary to resolve the issue.

4. If the condition of the building is not acceptable for the placement of the equipment, store it temporarily in an off-site warehouse. Ensure the same steps as noted above are performed before the equipment is off-loaded by the receiving contractor.

5. To prevent the absorption and retainage of moisture, verify there is no excessive moisture in the material used for dunnage within the project's deliveries.

AAA. With Trade Partners, perform and log the inspections of the equipment as well as the condition of the building twice a day at the beginning and end of the shift.

1. Note: The purpose of this inspection is to verify no temporary openings in the building or equipment are left uncovered and all doors are closed and latched (conduits and pipes should be sealed, for example).

2. To prevent the formation of condensation, record the condition of the building, temporary equipment, and permanent equipment on a daily basis to ensure they are being maintained properly.

3. Ensure all equipment is wrapped and heated at the beginning and end of each shift.

BBB. Implement equipment environmental protection during the temporary phase of construction and until the HVAC systems are fully commissioned and operational.

1. Utilize temporary HVAC equipment to condition the building during equipment installation, assembly, and start-up.

2. To keep the temperature above the dew point, install temporary thermostats and/or humidistats to monitor the interior temperature, humidity, and dew point of the building and/or equipment enclosures.

CCC. Ensure to take special considerations for the temperature monitoring in battery rooms.

DDD. Once the equipment is placed in the building, energize the strip heaters in the equipment (if equipped). If strip heaters cannot be immediately energized, ensure incandescent work lights will be installed in all sections of the equipment to keep the equipment warmer than the ambient temperature.

1. Include the strip heaters in the LOTO plan when workers are working in the vicinity of the thermal hazard for inspection and installation activities.

2. Produce a gSheet inspection log for daily review of operational status of all equipment anti-condensation heaters.

EEE. Develop a Temporary Maintenance Plan to ensure an acceptable level of air quality once the HVAC system is placed online. Confirm Indoor Air Quality (IAQ) measures are implemented during the remaining construction.

FFF. To reduce and/or prevent dust and debris from entering the equipment during construction and commissioning activities, install air filters on all open grills and louvers to the electrical equipment (PMDCs, for example).

GGG. Examples of measures to prevent moisture:

1. Installing desiccant material or hygroscopic substances that are used to induce or sustain a state of dryness inside the equipment

2. Installing temporary window enclosures (plastic sheeting, for example)

3. Confirming that all roof drains are properly installed and tied into the system

4. Providing industrial fans to immediately address ponding water

5. Drying out or removing any water damaged materials immediately
6. Providing temporary humidity control locally

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

3.1

END OF SECTION

REVISION HISTORY

Version	Date	Description and location of change
1	April 2021	Initial version.
2	September 2022	Updated Part 0.

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; and comparable products.

B. Related Requirements:

1. Section 017836 "Warranties" for executing, assembling, and submitting warranties.

1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.
3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2 "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.

1. Evaluation of Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight,

dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.

D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:

1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.

E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."

F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.

1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:

a. Name of product and manufacturer.
b. Model and serial number.
c. Capacity.

d. Speed.
e. Ratings.

3. See individual identification Sections in Divisions 21, 22, 23, and 26 for additional equipment identification requirements.

1.5 COORDINATION

A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and that products are undamaged and properly protected.

C. Storage:

1. Provide a secure location and enclosure at Project site for storage of materials and equipment.
2. Store products to allow for inspection and measurement of quantity or counting of units.
3. Store materials in a manner that will not endanger Project structure.
4. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection from wind.
5. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

a. Submit additional documentation required by Architect in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by the Architect, whose determination is final.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."

2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."

3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."

4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.

   a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
   b. Provision of an unnamed product is not considered a substitution if the product complies with requirements.

5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

   a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."

6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.

   a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
   b. Provision of products of an unnamed manufacturer is not considered a substitution if the product complies with requirements.

7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

   a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

C. Visual Matching Specification: Where Specifications require the phrase "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

E. Sustainable Product Selection: Where Specifications require product to meet sustainable product characteristics, select products complying with indicated requirements. Comply with requirements in Division 01 sustainability requirements Section and individual Specification Sections.

1. Select products for which sustainable design documentation submittals are available from manufacturer.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with the following requirements:

1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes, such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

B. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation, as specified in Section 013300 "Submittal Procedures."

1. Form of Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

C. Submittal Requirements, Two-Step Process: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

D. Submittal Requirements, Single-Step Process: When acceptable to Architect, incorporate specified submittal requirements of individual Specification Section in combined submittal for comparable products. Approval by the Architect of Contractor's request for use of comparable product and of individual submittal requirements will also satisfy other submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 016400
OWNER-FURNISHED PRODUCTS

TABLE OF CONTENTS

PROJECT-SPECIFIC AMENDMENTS

GENERAL
- RELATED DOCUMENTS
- SECTION INCLUDES
- DEFINITIONS
- CONTRACTOR RESPONSIBILITIES
- PRODUCT HANDLING
- QUALITY ASSURANCE

PRODUCTS
- OWNER-FURNISHED/CONTRACTOR-INSTALLED (OFCI) PRODUCTS
- OWNER-FURNISHED/OWNER-INSTALLED (OFOI) PRODUCTS

EXECUTION
- SURFACE CONDITIONS
- INSTALLATION
- ADJUSTING AND CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract.
B. 01 40 00 - Quality Requirements
C. 016000 - Product Requirements
D. 019113 - General Commissioning Requirements

1.2 SECTION INCLUDES

E. Requirements for installing Owner-furnished products, including providing miscellaneous items and accessories for a complete, functioning installation.

1.3 DEFINITIONS

F. OFE (Owner Furnished Equipment) is equipment or materials tendered and contracted by the Owner directly with a third-party supplier or vendor (Supplier). In no event shall the Contractor or any Subcontractor make modifications to OFE without the prior written approval of the Owner. OFE is either:

1. OWNER FURNISHED, CONTRACTOR INSTALLED (OFCI): Equipment installed by the Contractor as part of the Work. Verifies mounting and utility requirements for accepted products. Provides mounting and utility rough-ins.

2. OWNER FURNISHED, OWNER INSTALLED (OFOI): Equipment installed by the Owner’s Supplier or by another separate contractor retained by the Owner, but requiring surfacing, backing, utility connections or other preparation under this contract, for proper installation.

3. NOT IN CONTRACT (NIC): Products or equipment to be provided and installed by Owner, not requiring surfacing, backing, utility connections, or other preparation under this contract.

1.4 CONTRACTOR RESPONSIBILITIES

G. Coordinates directly with the Regional Supply Chain Manager (RSCM) Supplier with respect to all equipment and materials, regardless of procurement method, for the completion of the Work in accordance with the Project Milestones. Without limiting the foregoing, coordinates with the RSCM Supplier and the Owner for the delivery of designated equipment and materials.

H. Executes all product installations, except where Owner installation is noted.
I. Reviews and approves technical documents from the Supplier for compliance with Project requirements, including, but not limited to, the following: specifications, drawings, RFIs (Requests for Information), engineered drawings, submittals, as-builts, and test scripts. If such

Supplier has been retained by Owner (and not by Contractor as a Subcontractor under the Agreement between Owner and Contractor), Contractor shall not have the obligation to approve such documents but Contractor shall be responsible to promptly report to the Owner and A/E (as defined in the Agreement between Owner and Contractor) any errors, omissions or inconsistencies discovered by the Contractor in the course of Contractor's review of such documents.

J. Incorporates Owner-furnished products into the construction schedule.
K. Products Identified with Contractor Responsibility for Installation: If the Owner substitutes items similar to those scheduled, there shall be no change in rough-in cost, unless substitution occurs after rough-in has been completed or rough-in involves other mounting requirements, or utilities of different capacity than those required by item originally specified or identified in canonical design. No cost if what Owner provides is already identified in canonical design.
L. Rough-in locations, sizes, capacities, and similar types shall be as indicated and required by product manufacturers. Approved manufacturer's printed descriptions, specifications, and recommendations shall govern the Work, unless specifically indicated otherwise.
M. Coordinates deliveries and arranges for the delivered products to be suitably stored at time of delivery.
N. Coordinates deliveries to designated locations on a timely basis.
O. Schedules pre-construction conferences to enhance coordination efforts.
P. Schedules proper sequence of installation.
Q. Receives, unloads, handles, and protects Owner-furnished products at the site. Products should be inspected for damage upon delivery. Report damage and submission of Delivery Acceptance within 24 hours through BIM 360 Field.
R. Insures Owner-furnished products following receipt.
S. Prepares Owner-furnished products prior to installation, including substrate preparation, blocking, and other necessary construction procedures to facilitate installation of the product.
T. Cleans and protects installed Owner-furnished products until final acceptance.
U. Electrical Components: Contractor shall comply with requirements specified in Division 26 - Electrical.
V. Mechanical Components: Contractor shall comply with requirements specified in Division 22 – Plumbing and Division 23 - HVAC.

1.5 PRODUCT HANDLING

W. Protection: Contractor shall use all adequate and reasonable means necessary to protect the materials of this Section before, during, and after installation and to protect completed Work, including products installed by others.
X. Storage: Contractor shall securely store and handle products upright and in accordance with the manufacturer's instructions. Stored products shall be kept on shipping dunnage to the greatest degree possible. Any off-site storage shall be subject to the Owner's prior inspection and approval.
Y. Replacements: In the event of damage, Contractor shall immediately repair all damaged and defective Work to satisfaction of Owner's Representative, at no change in Contract Time and Contract Sum.
Z. Refer to requirements listed in Section 016000 Product Requirements.

1.6 QUALITY ASSURANCE

AA. General:

1. Furnish the tools, supplies, materials, products, and labor necessary for the installation, testing, and placing into operation of products and appurtenances, complete and operable, in accordance with the Contract Documents.
2. The provisions of this Section shall apply to the products specified, except where otherwise indicated in the Contract Documents.

BB. Contractor's Responsibility for Complete System:
1. Conduct or support field tests in accordance with Section 019113 - General Commissioning Requirements; correct issues related to installation.

2. In no event shall the Contractor or any Subcontractor make any modifications to OFE without the prior written approval of the Owner. For assistance, contact the project technical lead.

CC. Manufacturer's Responsibility for Products:
1. The Manufacturer of the Owner-furnished products shall be responsible for providing the following:
   a. Factory testing and certification of test results.
   b. O&M manual, including installation and storage instructions.
   c. Inspection and acceptance of the Contractor’s product installations.
   d. Approved Shop Drawings.
   e. Field services, to include startup and testing assistance.
   f. Training of the Owner's personnel.

DD. Manufacturer’s Service Representative: Installation, testing, and startup assistance specified in Section 019113 - General Commissioning Requirements.

EE. A/E of Record’s Responsibility for Information: The A/E of Record will make the following information available for the Contractor’s use: Shop Drawings of Owner-furnished products, including revisions as they affect the installation Work.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED/CONTRACTOR-INSTALLED (OFCI) PRODUCTS

FF. gPOR Configuration OFCI Product Table:

1. **Phase 1**

Product	Attribute
Cisco 9410 Chasis Switch	65lb 13RU
Cisco 9410 Chasis Switch	65lb 13RU
Arista DCS-7050CX3M	26lb 1RU
Arista DCS-7050CX3M	26lb 1RU
Cisco 9300 48P	16lb 1RU
Dell R740XD2S	88lb 1RU

Dell R740XD2S	88lb 1RU
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax

Phase 2

Product	Attribute
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP534	External antenna dual radio, 5GHz and 2.4GHz 802.11ax
Aruba AP ANT 48 Antenna	External antenna, 190 mm x 190 mm x 44 mm, 700g weight

Phase 3

Product	Attribute
Cisco 9300 48P	16lb 1RU
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax
WAP Aruba AP535	Internal antenna dual radio, 5GHz and 2.4GHz 802.11ax

2. Not Used.

2.2 OWNER-FURNISHED/OWNER-INSTALLED (OFOI) PRODUCTS

A. Products Furnished and Installed by Owner:

1. Contractor prepare; vendor install:

a. General: Contractor shall coordinate deliveries of vendor-supplied products. Vendor will furnish products to coincide with the construction schedule.

b. Vendor will:

1) Furnish standard integral components of products.

2) Deliver products to site.

3) Make connections to roughed-in utilities.

c. Contractor shall:

1) Provide rough-in of utility products in accordance with manufacturer's recommendations, instructions and shop drawings under supervision of the manufacturer's representative where specified.

2) Provide and install backing for all products weighing 20 pounds or more.

PART 3 - PART 3 EXECUTION

3.1 SURFACE CONDITIONS

A. Inspection:

1. Prior to commencing Work, Contractor shall verify that Work specified in other Sections has been properly completed and installed as specified to allow for installation of all materials and methods required of this Section.

2. Contractor shall verify that new and existing products and conditions are satisfactory for installation or relocation of OFCI products. If unsatisfactory conditions exist, do not commence the installation until such conditions have been corrected.

GG. Discrepancies:

1. In the event of discrepancy, Contractor shall immediately notify the Owner's Representative.

2. Contractor shall not proceed with installation in areas of discrepancy until all such discrepancies have been resolved.

3.2 3.2 INSTALLATION

A. Contractor shall relocate and reinstall existing products in accordance with Contract Documents and review shop drawings, original manufacturer's instructions and recommendations if applicable and as directed.

B. Contractor shall install Owner-furnished products in accordance with reviewed shop drawings and manufacturer's printed instructions, as applicable.

3.3 QUALITY CONTROL

A. Give full access to Work by, and cooperate with, the Manufacturer during testing to enable the gathering of data and information necessary to evaluate performance and develop recommendations for acceptable O&M instructions.

B. Inspection of Products:
   1. Satisfactory arrival of products that meet requirements of 016000 Product Requirements.
   2. Damage to or loss of products and materials shall be immediately reported to the A/E of Record.
   3. Damage to or loss of products and materials after the date of transfer to the Contractor shall be repaired or replaced at the Contractor's expense.

3.3 ADJUSTING AND CLEANING

A. Contractor shall adjust products as necessary and as directed by Owner's Representative.

B. Contractor shall clean all new and relocated OFCI products.

HH. Contractor shall protect OFCI products from damage until Contract Completion.

3.4 STARTUP

A. Coordinate the requirements listed in Section 019113 - General Commissioning Requirements regarding commissioning and startup unless otherwise specified.

END OF SECTION

REVISION HISTORY

Version	Date	Description and location of change
1	Oct 2020	Initial version
2	Mar 2021	Added 1.6 B.2.
3	Sept 2022	Updated Part 0.

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:

1. Construction layout.
2. Field engineering.
3. Installation.
4. Cutting and patching.
5. Progress cleaning.
6. Pest control.
7. Starting and adjusting.
8. Protection of installed construction.
9. Correction of the Work.

B. Related Requirements:

1. Section 011000 "Summary" for limits on use of Project site.
2. Section 013300 "Submittal Procedures" for submitting surveys.
3. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
4. Section 078413 "Penetration Firestopping" for patching penetrations in fire-rated construction.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.4 PREINSTALLATION MEETINGS

A. Cutting and Patching Conference: Conduct conference at Project site.

1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Inform Architect of scheduled meeting. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:

    a. Contractor's superintendent.
    b. Trade supervisor responsible for cutting operations.
    c. Trade supervisor(s) responsible for patching of each type of substrate.
    d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affected by cutting and patching operations.

2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

B. Layout Conference: Conduct conference at Project site.

1. Prior to establishing layout of new perimeter and structural column grid(s), review building location requirements. Review benchmark, control point, and layout and dimension requirements. Inform Architect of scheduled meeting. Require representatives of each entity directly concerned with Project layout to attend, including the following:

    a. Contractor's superintendent.
    b. Professional surveyor or professional engineer responsible for performing Project surveying and layout.

2. Review meanings and intent of dimensions, notes, terms, graphic symbols, and other layout information indicated on the Drawings.
3. Review requirements for including layouts on Shop Drawings and other submittals.
4. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor or professional engineer.

B. Certificates: Submit certificate signed by land surveyor or professional engineer, certifying that location and elevation of improvements comply with requirements.

C. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:

1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
3. Products: List products to be used for patching and firms or entities that will perform patching work.
4. Dates: Indicate when cutting and patching will be performed.

5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.

    a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

D. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.6 CLOSEOUT SUBMITTALS

A. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

1.7 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in the jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Professional Engineer Qualifications: Refer to Section 014000 "Quality Requirements."

C. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:

    a. Primary operational systems and equipment.
    b. Fire separation assemblies.
    c. Air or smoke barriers.
    d. Fire-suppression systems.
    e. Plumbing piping systems.
    f. Mechanical systems piping and ducts.
    g. Control systems.
    h. Communication systems.
    i. Fire-detection and -alarm systems.
    j. Conveying systems.
    k. Electrical wiring systems.

l. Operating systems of special construction.

3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:

a. Water, moisture, or vapor barriers.
b. Membranes and flashings.
c. Sprayed fire-resistive material.
d. Equipment supports.
e. Piping, ductwork, vessels, and equipment.
f. Noise- and vibration-control elements and systems.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with requirements specified in other Sections.

1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.

C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
2. List of detrimental conditions, including substrates.
3. List of unacceptable installation tolerances.
4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to

other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect in accordance with requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Architect promptly.

B. Engage a land surveyor professional engineer experienced in laying out the Work, using the following accepted surveying practices:

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish limits on use of Project site.
3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

C. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

D. Final Property Survey: Engage a land surveyor professional engineer to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor or professional engineer, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.

1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.

4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces, unless otherwise indicated on Drawings.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.

F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.

G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Architect. Fit exposed connections together to form hairline joints.

3.6 CUTTING AND PATCHING

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of Work to be cut.

D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

F. Patching: Patch construction by filling, repairing, refinishing, closing, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

    a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall

coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

G. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 PROGRESS CLEANING

A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, in accordance with regulations.

a. Use containers intended for holding waste materials of type to be stored.

4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces in accordance with written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 PEST CONTROL

A. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.

3.9 STARTING AND ADJUSTING

A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."

B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.10 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.

C. Comply with manufacturer's written instructions for temperature and relative humidity.

3.11 CORRECTION OF THE WORK

A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Repair work previously completed and subsequently damaged during construction period. Repair to like-new condition.

C. Restore permanent facilities used during construction to their specified condition.

D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous construction waste.
2. Recycling nonhazardous construction waste.
3. Disposing of nonhazardous construction waste.

1.3 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.

B. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

C. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.

D. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner’s property.

E. Hazardous: Exhibiting the characteristics of hazardous substances— that is, ignitability, corrosivity, toxicity or reactivity.

F. Nonhazardous: Exhibiting none of the characteristics of hazardous substances— that is, ignitibility, corrosively, toxicity, or reactivity.

G. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

H. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

I. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

J. Return: To give back reusable items or unused products to vendors for credit.

K. Reuse: To reuse construction waste material in some manner on the project site.

L. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

M. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

N. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

O. Toxic: Poisonous to humans either immediately or after a long period of exposure.

P. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

Q. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.

1.5 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 30 days of date established for the Notice of Award.

1.6 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use form acceptable to Owner. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons.
4. Quantity of waste salvaged, both estimated and actual in tons.
5. Quantity of waste recycled, both estimated and actual in tons.
6. Total quantity of waste recovered (salvaged plus recycled) in tons.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

D. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

E. Qualification Data: For waste management coordinator.

1.7 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements. Superintendent may serve as Waste Management Coordinator.

B. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

C. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of each contractor and waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of site-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use form acceptable to Owner.[. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
2. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
3. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
4. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there were no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use form acceptable to Owner. Include the following:

1. Total quantity of waste.
2. Estimated cost of disposal (cost per unit). Include transportation and tipping fees and cost of collection containers and handling for each type of waste.
3. Total cost of disposal (with no waste management).
4. Revenue from salvaged materials.
5. Revenue from recycled materials.
6. Savings in transportation and tipping fees by donating materials.
7. Savings in transportation and tipping fees that are avoided.
8. Handling and transportation costs. Include cost of collection containers for each type of waste.
9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling a minimum of 75 percent by weight of total nonhazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

a. Paper.
b. Cardboard.
c. Boxes.
d. Plastic sheet and film.

e. Polystyrene packaging.
f. Wood crates.
g. Wood pallets.
h. Plastic pails.

2. Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following construction office waste materials:

a. Paper.
b. Aluminum cans.
c. Glass containers.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.

3.2 RECYCLING CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

    a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.3 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Paint: Seal containers and store by type.

3.4 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Final cleaning.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for submitting Final Completion construction photographic documentation.
2. "DCDE HUB Project Closeout Checklist."
3. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
4. Section 017836 "Warranties" for administrative and procedural requirements for executing, assembling, and submitting warranties and service and maintenance contracts.
5. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
6. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.3 DEFINITIONS

A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for the Architect's use prior to Architect's inspection, to determine if the Work is substantially complete.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of cleaning agent.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.5 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

C. Field Report: For pest-control inspection.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items required by other Sections.

1.7 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner. Label with manufacturer's name and model number.

    a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Owner's signature for receipt of submittals.

5. Submit testing, adjusting, and balancing records.
6. Submit sustainable design submittals not previously submitted.
7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.
2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
3. Complete startup and testing of systems and equipment.
4. Perform preventive maintenance on equipment used prior to Substantial Completion.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
6. Advise Owner of changeover in utility services.
7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
9. Complete final cleaning requirements.
10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.8 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:

1. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
2. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
3. Submit pest-control final inspection report.
4. Submit Final Completion photographic documentation.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On

receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.9 LIST OF INCOMPLETE ITEMS

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, starting with exterior areas first, listed by room or space number.
2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

    a. Project name.
    b. Date.
    c. Name of Architect and Construction Manager.
    d. Name of Contractor.
    e. Page number.

4. Submit list of incomplete items in the following format:

    a. Web-Based Project Software Upload: Utilize software feature for creating and updating list of incomplete items (punch list).

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Remove snow and ice to provide safe access to building.
f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Clean flooring, removing debris, dirt, and staining; clean according to manufacturer's recommendations.
i. Vacuum and mop concrete.
j. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
l. Remove labels that are not permanent.
m. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
p. Clean ducts, blowers, and coils.
q. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
r. Clean strainers.
s. Leave Project clean and ready for occupancy.

C. Pest Control: Comply with pest control requirements in Section 017300 "Execution." Prepare written report.

D. Construction Waste Disposal: Comply with waste-disposal requirements in Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations required by Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Emergency manuals.
2. Systems and equipment operation manuals.
3. Systems and equipment maintenance manuals.
4. Product maintenance manuals.

B. Related Requirements:

1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
2. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Architect and Commissioning Authority will comment on whether content of operation and maintenance submittals is acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:

1. Submit by uploading to web-based project software site. Enable reviewer comments on draft submittals.

C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect and Commissioning Authority will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect and Commissioning Authority will return copy with comments.

1. Correct or revise each manual to comply with Architect's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's and Commissioning Authority's comments and prior to commencing demonstration and training.

E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

B. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes. Paper copy versions may not be required as determined for each site and approved in writing by Owner.

1. Binders: Heavy-duty, three-ring, binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

a. Binder Product: SHP Turned Edge Binder or equal.

1) http://shop.pageprotectors.com/TurnedEdgeBinderLetterSHPCloneClassic11x853InchCSH11853.htm.

b. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
c. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for Architect.
8. Name and contact information for Commissioning Authority.
9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
10. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 EMERGENCY MANUALS

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

E. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.

2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Operating standards.
3. Operating procedures.
4. Operating logs.
5. Wiring diagrams.
6. Control diagrams.
7. Piped system diagrams.
8. Precautions against improper use.
9. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.

4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed and identify color coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

SECTION 017836 - WARRANTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for executing, assembling, and submitting warranties and service and maintenance contracts including, but not limited to, the following:

1. Compile specified warranties and service and maintenance contracts.
2. Review to verify compliance with Contract Documents.

B. Related Requirements:

1. Section 013300 "Submittal Procedures" for administrative and procedural requirements for submittals.
2. Section 017700 "Closeout Procedures" for general closeout procedures.
3. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
4. Individual Specification Sections requiring warranties and service/maintenance contracts.

1.3 DEFINITIONS

A. Warranty: A written statement in which the Contractor, Subcontractor, Vendor, Supplier, Manufacturer, or other applicable party warrants to the Owner that their portion of the Work is complete, functional, and free from defects in materials and workmanship; and the party promises to remedy any such defects that may be discovered during a specified warranty period, at no cost and to the satisfaction of the Owner.

B. Substantial Completion: Refer to Construction Agreement.

1.4 SUBMITTALS

A. Closeout Submittals:

1. Warranty Information: For each applicable warranty, provide:

a. Vendor/Contractor Name.
b. Point of Contact.

c. Warranty Start and End Dates.
d. Assets/Locations Covered using One GDC Naming Convention.
e. Specific Components if Warranty Coverage differs within the asset/location.
f. Terms and Conditions.
g. Point of Contact for escalation.

2. Warranties: Submit two (2) sets of original signed copies executed by respective Manufacturers, Suppliers, and Subcontractors as follows:

a. Contents: Enter in sequence the following information for each item:

1) Product or work item, including asset identification, that is, manufacturer
2) part number (MPN).
3) Subcontractor, supplier and manufacturer's name, address, and
4) telephone number.
5) Warranty Start Date and duration time of warranty.
6) Proper procedure in case of failure.
7) Instances that might affect validity of warranty.
8) Bind each set in 8 1/2 inches by 11 inches commercial quality, 3-ring, D-type binders with durable and cleanable plastic covers. Identify each binder with typed or printed titles of Project, Location, Date, and Owner. No hand lettering.

b. Input each set into the Owner provided template for electronic copy. Identify each template file with title of Project, Location, Date, and Owner in the following format: [year.mm.dd] _[Project]_[Location]_[Owner]

3. Maintenance Records: Provide two (2) copies of records. Records shall include:

a. Identification for piece of equipment or component serviced (project or drawing label information; manufacturer; model number; serial number).
b. Date of service
c. Service record including what was done; key observations; order/purchase documentation for any parts replaced, lubricants applied, filters changed, etc.; name of company doing the service and contact information; service technician's name; and signoffs by Contractor's QA/QC staff. Where applicable, include government required records (for example, if refrigerant was added to an HVAC system).
d. Bind each set in 8 1/2 inches by 11 inches commercial quality, 3-ring, D-type binders with durable and cleanable plastic covers. Identify each binder with typed or printed titles with title of Project, Location, Date, and Owner. No hand lettering.
e. Individual equipment service records shall also be uploaded to the Cx tracking tool and attached to the appropriate piece of equipment.

1.5 TIME OF SUBMITTALS

A. For equipment or component parts of equipment placed into service during progress of construction, submit Documents within ten (10) days after Final Inspection and Final Acceptance.

B. Make other submittals within ten (10) days after Date of Facility Ready (FR) of project before Final Request for Payment.

C. For items of Work, where acceptance is delayed materially beyond Date of Facility Ready (FR) of project, provide updated submittal within ten (10) days after Final Acceptance, listing Date of Final Acceptance as start of Warranty Period.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 WARRANTY WORK REQUESTS

A. Refer to "Contractor's Warranties" Article in the Construction Agreement. In accordance with that Article, the Contractor shall provide a one (1) year end-to-end (comprehensive) warranty for the Work, covering all labor, equipment, and materials required to repair or replace. Retesting or recommissioning of repaired or replaced equipment, as applicable, shall also be covered, including additional CxA fees. The Warranty shall start at Substantial Completion. The comprehensive warranty shall apply in addition to any other warranties required elsewhere in the Contract Documents (for example, a five (5) year manufacturer's warranty on an HVAC compressor).

B. All warranties shall be between the Owner and the responsible party; however, for a period of one year following Date of Facility Ready (FR), the Contractor shall manage and track the Warranty Process, and shall be responsible for directing Owner warranty requests to the appropriate Subcontractor, Vendor, or other responsible party. Contractor shall provide the services of a designated Warranty Manager to act as the warranty Point of Contact (POC) and to perform warranty management during the one-year period. The Warranty Manager will not be required to be on site but must be easily accessible and responsive.

C. Owner shall set up a Warranty Tracking Sheet and Warranty Submission Form and share them with the Warranty Manager electronically.

D. If Owner determines that warranty work is needed, they will contact the Contractor's Warranty Manager through email.

E. The Warranty Manager must respond to the email within ten (10) days, accepting or rejecting the request. Rejected requests will follow an escalation process that starts with the Contractor.

1. For all accepted warranty requests, the Subcontractor, Vendor, or other responsible party shall provide to the Owner an action plan for remedying the request within ten (10) days of accepting the request. The action plan shall include a draft schedule and draft Work Notification for the warranty work.

F. The Warranty Manager shall actively manage warranty requests and ensure Subcontractors, Vendors, and other responsible parties follow up on warranty requests. The Warranty Manager shall:

1. Intervene if a Subcontractor/Vendor or other responsible party has failed to respond to a warranty request within ten (10) days.
2. Manage and facilitate the action plan and Work Notification process for the Subcontractor/Vendor or other responsible party.
3. Communicate with the Subcontractor/Vendor/Responsible party and Owner points of contact to coordinate logistics (Work Notification, site security access, Owner escorts and operational support, material movement, site coordination, and so on) pertaining to the warranty work.
4. Arrange for and coordinate retesting and recommissioning of the portion of the Work affected by the Warranty claim if that is requested by the Owner.
5. Arrange for and coordinate Owner's acceptance review of the completed Warranty work. The Warranty Manager shall document the outcome of the review, including any comments/punch list items and resolution of those comments/punch list items.

G. When warranty work is complete, the Warranty Manager or responsible party shall update the Work Notification to fully document the work done. For example, if a pump was replaced, then the manufacturer, model and serial number of the replacement unit shall be added to the Work Notification. Similarly, if there was a deviation from plans or specifications, this shall also be documented. The Owner will use this data to document these changes in Maximo.

H. The Warranty Manager shall schedule and attend a full-day on-site warranty walk and meeting with the Owner's POC at 11 months after Date of Facility Ready (FR) to review open issues and reveal new ones.

I. At the end of the one (1) year period, the Warranty Manager shall hand off all records of completed and pending Warranty work, including status updates and POCs for pending items, to the Owner's POC.

3.2 MAINTENANCE

A. For equipment, or component parts of equipment, placed into service during progress of construction, Contractor shall be responsible for maintenance of this equipment or component parts during the period between the date it was placed into service and the date of Final Acceptance of the equipment or components.

1. Contractor maintenance shall be done in accordance with the Operation and Maintenance Manual provided for the equipment or components; at the cadence recommended by the manufacturer; and using parts and materials approved by the manufacturer. Maintenance shall be done by technicians trained and certified by the manufacturer to perform work on the equipment.
2. Contractor shall maintain records of all maintenance done and submit these records to the Owner after Final Acceptance as indicated in Submittal paragraphs above.
3. If the manufacturer's recommended maintenance cadence (schedule) requires a maintenance item 30 days or less after the date of Acceptance by Owner, Contractor shall provide urgent notification to Owner that these items are pending at the time of Acceptance, so that the Owner's staff will be aware. Include lead time information for any necessary parts, and POCs and contact information for applicable service companies qualified to do the work.

END OF SECTION 017836

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for Project Record Documents, including the following:

1. Record Drawings.
2. Record specifications.
3. Record Product Data.
4. Miscellaneous record submittals.

B. Related Requirements:

1. Section 017300 "Execution" for final property survey.
2. Section 017700 "Closeout Procedures" for general closeout procedures.
3. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit copies of Record Drawings as follows:

a. Initial Submittal:

1) Submit annotated PDF electronic files.
2) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.

b. Final Submittal:

1) Submit annotated PDF electronic files.

B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and Contract modifications.

C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

E. Reports: Submit written report weekly indicating items incorporated into Project Record Documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.4 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

    a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    b. Accurately record information in an acceptable drawing technique.
    c. Record data as soon as possible after obtaining it.
    d. Record and check the markup before enclosing concealed installations.
    e. Cross-reference record prints to corresponding photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

    a. Dimensional changes to Drawings.
    b. Revisions to details shown on Drawings.
    c. Depths of foundations.
    d. Locations and depths of underground utilities.
    e. Revisions to routing of piping and conduits.
    f. Revisions to electrical circuitry.
    g. Actual equipment locations.
    h. Duct size and routing.
    i. Locations of concealed internal utilities.
    j. Changes made by Change Order or Construction Change Directive.
    k. Changes made following Architect's written orders.
    l. Details not on the original Contract Drawings.
    m. Field records for variable and concealed conditions.
    n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.

4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Annotated PDF electronic file with comment function enabled.
2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
3. Refer instances of uncertainty to Architect for resolution.
4. Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.

    a. See Section 013100 "Project Management and Coordination" for requirements related to use of Architect's digital data files.
    b. Architect will provide data file layer information. Record markups in separate layers.

C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Format: Annotated PDF electronic file with comment function enabled.
2. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
3. Identification: As follows:

    a. Project name.
    b. Date.
    c. Designation "PROJECT RECORD DRAWINGS."
    d. Name of Architect.
    e. Name of Contractor.

1.5 RECORD SPECIFICATIONS

A. Preparation: Update Specification files to indicate the actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Update copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.

4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
5. Note related Change Orders, Record Product Data, and Record Drawings where applicable.

B. Format: Submit record specifications as annotated PDF electronic file.

1.6 RECORD PRODUCT DATA

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until end of Project.

B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

C. Format: Submit Record Product Data as annotated PDF electronic file.

1. Include Record Product Data directory organized by Specification Section number and title, electronically linked to each item of Record Product Data.

1.7 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.8 MAINTENANCE OF RECORD DOCUMENTS

A. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Instruction in operation and maintenance of systems, subsystems, and equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Attendance Record: For each training module, submit list of participants and length of instruction time.

1.4 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.

1.6 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Operating standards.
    c. Regulatory requirements.
    d. Equipment function.
    e. Operating characteristics.
    f. Limiting conditions.
    g. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Systems and equipment operation manuals.
    c. Systems and equipment maintenance manuals.
    d. Product maintenance manuals.
    e. Project Record Documents.
    f. Identification systems.
    g. Warranties and bonds.
    h. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.

d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning.
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

1.7 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

1.8 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 017900

SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Owner's Project Requirements and Basis-of-Design Document are included by reference for information only.

C. ASHRAE Guideline 0 and 1.

D. Project’s Commissioning Plan: The commissioning plan is prepared by the Commissioning Authority (CxA) and expands and makes more specific the information contained here.

1.2 SUMMARY

A. The Commissioning (Cx) process requires the active involvement of the responsible builder and the affected Division contractors (Subs) and assigns work and responsibilities that are specified here. For this specification responsible builder refers to "Construction Manager", "CM", “General Contractor”, or “Prime Contractors”.

B. The responsible builder is responsible for obtaining from contractors all documentation related to the commissioning effort and submitting it to the commissioning authority.

C. All system and equipment startup will be conducted by the respective manufacturers and contractors.

D. Functional and integrated testing shall be performed by the contractors and supervised, witnessed, and verified by the commissioning authority.

E. This specification is to be used in conjunction with all other contract documents. Any discrepancies or conflicts shall be identified, and the Owner and Construction Manager shall be notified in writing. A clarification will then be issued to the appropriate parties and entities.

F. Section Includes:

1. General requirements for coordinating and scheduling commissioning activities.
2. Commissioning meetings.
3. Commissioning reports.
4. Use of commissioning process test equipment, instrumentation, and tools.
5. Construction checklists, including, but not limited to, installation checks, startup, performance tests, and performance test demonstration.
6. Commissioning tests and commissioning test demonstrations.
7. Adjusting, verifying, and documenting identified systems and assemblies.

G. Related Requirements:

1. Section 013300 "Submittal Procedures" for submittal procedure requirements for commissioning process.
2. Section 017700 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.
3. Section 017823 "Operation and Maintenance Data" for preliminary operation and maintenance data submittal requirements.
4. Section 220800 "Commissioning of Plumbing" for technical commissioning requirements for plumbing.
5. Section 230800 "Commissioning of HVAC" for technical commissioning requirements for HVAC.
6. Section 260800 "Commissioning of Electrical Systems" for technical commissioning requirements for electrical systems.
7. Section 280800 “Commissioning of Electronic Safety and Security Systems for technical commissioning requirements for security and life safety.

H. If the Architect or the Commissioning Authority performs additional services or incur additional expenses due to actions of Contractor listed in this specification, compensate the Owner to refund the Architect or the Commissioning Authority for such additional services and expenses.

1. Failure to provide timely notice of commissioning activities schedule changes.
2. Failure to meet acceptance criteria for test demonstrations.
3. More than one failed equipment test.

I. Contractor shall compensate Owner for such additional services and expenses at the rate of $175 per labor hour, plus $1000 per round trip for personnel travelling more than 200 miles, plus per diem allowances for meals and lodging according to current U.S. General Services Administration (GSA) Per Diem Rates.

1.3 DEFINITIONS

A. Acceptance Criteria: Threshold of acceptable work quality or performance specified for a commissioning activity, including, but not limited to, construction checklists, performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.

B. Basis-of-Design Document: A document prepared by Architect that records concepts, calculations, decisions, and product selections used to comply with Owner's Project Requirements and to suit applicable regulatory requirements, standards, and guidelines.

C. Commissioning Authority/Provider: An entity engaged by Owner to evaluate Commissioning-Process Work.

D. Commissioning Plan: A document, prepared by Commissioning Authority, that outlines the organization, schedule, allocation of resources, and documentation of commissioning requirements.

E. Commissioning: A quality-focused process for verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, and tested to comply with

Owner's Project Requirements. The requirements specified here are limited to the construction phase commissioning activities.

F. Construction-Phase Commissioning-Process Completion: The stage of completion and acceptance of commissioning process when resolution of deficient conditions and issues discovered during commissioning process and retesting until acceptable results are obtained has been accomplished. Owner will establish in writing the date construction-phase commissioning-process completion is achieved.

1. Commissioning process is complete when the Work specified of this Section and related Sections has been completed and accepted, including, but not limited to, the following:

a. Completion of tests and acceptance of test results.
b. Resolution of issues, as verified by retests performed and documented with acceptance of retest results.
c. Comply with requirements in Section 017900 "Demonstration and Training."
d. Completion and acceptance of submittals and reports.

G. Owner's Project Requirements: A document that details the functional requirements of a project and the expectations of how it will be used and operated, including Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. This document is prepared either by the Owner or for the Owner by the Architect or Commissioning Authority.

H. Owner's Witness: Commissioning Authority, Owner's Project Manager, or Architect-designated witness authorized to authenticate test demonstration data and to sign completed test data forms.

I. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

J. Test: Performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.

K. Sampling Procedures and Tables for Inspection by Attributes: As defined in the Commissioning Plan.

1.4 COMMISSIONING TEAM

A. Members Appointed by Contractor(s):

1. Commissioning Coordinator: A person or entity employed by Contractor to manage, schedule, and coordinate commissioning process.
2. Project superintendent and other employees that Contractor may deem appropriate for a particular portion of the commissioning process.
3. Subcontractors, installers, suppliers, and specialists that Contractor may deem appropriate for a portion of the commissioning process.
4. Appointed team members shall have the authority to act on behalf of the entity they represent.

B. Members Appointed by Owner:

1. Commissioning Authority, plus consultants that Commissioning Authority may deem appropriate for a portion of the commissioning process.
2. Owner representative(s), facility operations and maintenance personnel, plus other employees, separate contractors, and consultants that Owner may deem appropriate for a portion of the commissioning process.
3. Architect, plus employees and consultants that Architect may deem appropriate for a portion of the commissioning process.

1.5 COMMISSONING RELATED DOCUMENTS:

A. Commissioning documents provided by the CxA:

1. Commissioning Specifications
2. Commissioning Plan:

   a. Contractor personnel and subcontractors/responsible builders participating in the commissioning. List of Contractor-appointed commissioning team members to include specific personnel and subcontractors/responsible builders performing the various commissioning requirements.
   b. List of the systems that are to be commissioned.
   c. Commissioning schedule: Includes the commissioning activities in the overall project schedule with allocating time for each assembly or system test.

3. Pre-functional Checklists for specific systems and equipment: Checklists and procedures with specific spaces for recording and documenting the inspection of each procedure and a summary block for deficiencies and explanations. They include Material checks, Installation checks, and Startup procedures, where required.
4. Functional Performance Test Procedures for specific systems and equipment: Test scripts are provided to the Contractors, prior to testing for review and approval.
5. Issues Log in on-line or other form
6. Final Commissioning Report
7. In cooperation with the CxA, the Contractor shall integrate commissioning activities into the master construction schedule.
8. Two-week look-ahead schedules provided to the commissioning authority by the responsible builder.

B. Documents provided by the construction team during the construction phase:

1. Submittals: Comply with requirements in Section 013300 "Submittal Procedures" for submittal procedure general requirements for commissioning process.
2. Test and balance plan.
3. Two-week look-ahead schedules provided to the commissioning authority by the Contractor.
4. Flush and fill plan.
5. Completed Pre-functional Checklists (PFCs) or certification of readiness.
6. Request for Certificate of Construction-Phase Commissioning Process Completion.

C. Documents provided by the construction team during the project closeout process:

1. Startup reports.
2. Approved Functional Performance Test (FPTs) scripts.
3. List unresolved issues and reasons they remain unresolved and should be exempted from the requirements for Construction-Phase Commissioning Completion.
4. Operation & Maintenance Manuals: For proprietary test equipment, instrumentation, and tools to include in operation and maintenance manuals.
5. As-built documents.

1.6 RESPONSIBLE BUILDER/CONTRACTOR RESPONSIBILITIES

A. Complete all equipment checklists, startup reports and any owner related documentation pertaining to the project and the equipment.

B. Prepare a preliminary schedule for commissioning activities for use by the Commissioning Authority and shall update the schedule as appropriate. The responsible builder shall notify the Commissioning Authority during the commissioning meetings when commissioning activities not yet performed or not yet scheduled will delay construction. Perform equipment installation and start up.

C. Confirm completion of the Test, Adjust and Balancing Contractor responsibilities, draft report submitted to the design engineer of record and their review completed and the final report accepted. Copy of draft report is to be provided as well to the Owner’s Representative and the CxA.

D. Control Contractor responsibilities completed including all programing, graphics and training has been scheduled with the Owner’s maintenance staff.

E. Verify the functional readiness of systems to be tested prior to scheduling and demonstrating the functional operational performance.

F. Provide CxA temporary read/write access to the building automation control system as well as remote access (if available) for the purposes of conducting functional testing.

G. Correct current Architect/Engineer punch list and Commissioning Authority deficiency items before functional and integrated performance testing can begin. Air and water TAB shall be completed with discrepancies and problems remedied before Functional Testing of the respective air or water related systems. Conduct functional performance testing in the presence of the CxA.

H. Correct deficiencies.

I. Perform functional performance retest if necessary.

J. Contractor shall provide a minimum of three business day’s notice to the Owner’s Representative of any changes in date, time, and location or anticipated duration of start-up and test activities. Tests that are not performed as scheduled shall be considered a failed test unless a minimum 48 hours’ notification of cancellation or rescheduling was received by all parties.

Contractor shall reimburse the Owner for costs incurred by the Owner as the result of failure to provide timely notice of changes in date, time, location, or anticipated duration of start-up and test activities, including costs associated with the CxA involvement.

K. Verify all punch list issues pertaining to the equipment have been addressed and resolved.

L. Provide operation and maintenance data.

1. Documents are project specific and include troubleshooting information.
2. Documentation will include emergency operation guidelines too.
3. Deliver the final O&M manuals to the CxA for review at least 60 days prior to scheduled training.

M. Perform Computer Maintenance Management System (CMMS) asset tagging according to Owner's CMMS Data Requirements and assigned project CMMS data template.

N. Prepare a training outline and submit to CxA for comment and approval.

1.7 QUALITY ASSURANCE

A. Contractors are to be knowledgeable and fully versed in the integration of the equipment. For example, if necessary, scheduling may be required for the Building Automation System (BAS) Testing Technician and the Boiler startup technician to work together to properly setup the boiler plant.

B. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of BAS, HVAC, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. This applies to the individual testing technician, not the contactors company.

C. HVAC Testing Technician Qualifications: Technicians to perform HVAC construction checklist verification tests, construction checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level. Vocational school four-year-program Graduate or an Associate degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC equipment, assemblies, and systems.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. This applies to the individual testing technician, not the contactors company.

D. Electrical Testing Technician Qualifications: Technicians to perform electrical Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level. Vocational school four-year-program Graduate or an Associate degree in electrical systems, or similar field. Degree may be offset by three years' experience as an apprentice or a journey-level electrician. Generally, required knowledge includes electrical and HVAC&R concepts, building operations, and application and use of tools and instrumentation to measure performance of electrical equipment, assemblies, and systems.
2. Minimum three years’ experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. This applies to the individual testing technician, not the contactors company.

E. Plumbing Testing Technician Qualifications: Technicians to perform plumbing construction checklist verification tests, construction checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of plumbing system, electrical concepts, and building operations.
2. Minimum three years’ experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. This applies to the individual testing technician, not the contactors company.

F. Test Adjust and Balance Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of BAS, HVAC, electrical concepts, and building operations.
2. Minimum three years’ experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. This applies to the individual testing technician, not the contactors company.

G. Specialty Testing Technician Qualifications: Technicians to perform Cx tests or equipment startups, are suggested to have the following minimum qualifications:

1. This applies to all specialty trades including lighting control systems, elevators or building exteriors for example.
2. Journey level or equivalent skill level with knowledge of BAS, HVAC, electrical concepts, plumbing concepts and building operations.
3. Minimum three years’ experience installing, servicing, and operating systems manufactured by approved manufacturer.
4. If required, test documents or letters of attendance may be requested for individuals attending training for the installation of the equipment.
5. This applies to the individual testing technician, not the contactors company.

1.8 COMMISSIONING OVERVIEW

A. The following provides a brief overview of typical commissioning tasks during construction and general order in which they occur.

1. CxA provides a commissioning plan to outline the commissioning process including the roles and responsibilities of the Owner, Design Professional, and Commissioning Agent. The plan shall also identify the logistics, schedules and management protocols associated with the commissioning process.
2. Contractors submit normal comprehensive product and execution submittals as specified.
3. Design team reviews submittals and returns to Contractors. CxA reviews submittals for equipment/systems in the commissioning program simultaneously with design team and submits comments to design team.
4. Design professional receives and reviews O&M manuals and submittals. The Contractor is to copy the CxA to allow their review for conformance to project intent.
5. Provide documentation the Commissioning Authority for development of pre-installation, installation, check, test, and start-up, and functional and integrated performance testing procedures. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any owner-contracted tests; fan and pump curves; full factory testing reports, if any; and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials shipped inside the equipment and the actual field checkout sheet forms to be used by the factory-trained manufacturer's field technicians shall be submitted to the Commissioning Authority. The Commissioning Authority may request further documentation necessary for the development of functional performance testing and the commissioning process. This data request may be made prior to normal submittals.
6. CxA completes development of functional performance tests based on submitted documentation and submits to commissioning team for review and comment, approximately one week prior to functional performance testing. Final format of testing protocols, based on review comments, are prepared by CxA and distributed.
7. The Contractor coordinates proper installation of equipment. The Contractor coordinates proper testing and balancing of the systems.
8. Assist in clarifying the proposed operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not enough for writing detailed testing procedures.
9. Functional performance testing for a system shall be scheduled upon completion of equipment installation, equipment startup, system testing and balancing and BAS point and programming checkout. The Contractor with responsibility for the functionality of a system demonstrates system functionality to CxA.
10. CxA compiles final commissioning report recommending acceptance of performance and functionality or recommends remedial action and re-testing. The final commissioning report outlines the Functional Testing procedures, summarizes the results of the functional performance testing, and identifies any outstanding deficiencies.

PART 2 - PRODUCTS

2.1 TESTING EQUIPMENT AND INSTRUMENTATION QUALITY AND CALIBRATION

A. Test equipment and instrumentation required to perform the commissioning process shall be provided by the Contractor and remain the property of Contractor unless otherwise indicated.

B. Test equipment and instrumentation required to perform commissioning process shall comply with the following criteria:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

C. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

a. Be calibrated by manufacturer with current calibration tags permanently affixed.
b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
c. All system proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

2.2 REPORT FORMAT AND ORGANIZATION

A. General Format and Organization:

1. Electronic Data: Portable document format (PDF); a single file with outline-organized bookmarks for major and minor tabs and tab contents itemized for specific reports.
2. Hard Copy, (if requested): Bind report in three-ring binders. Label the front cover and spine of each binder with the report title, volume number, project name, Contractor's name, and date of report.

PART 3 - EXECUTION

3.1 PREPARATION

A. Review preliminary construction checklists and preliminary test procedures and data forms.

3.2 CONSTRUCTION CHECKLISTS

A. Include in construction checklists applicable contract requirements, manufacturer's standard installation requirements, issues that impact the ability of the installation to comply with test acceptance criteria, and issues that impede safe access for testing, maintenance, operation and replacement, at minimum.

B. Construction checklists cannot modify or conflict with the Contract Documents.

C. The CxA creates construction checklists based on actual systems and equipment to be included in Project.

1. The construction checklists are completed by the contractor and sub-contractors relevant to the piece of equipment or system.

D. Material Checks:

1. Compare specified characteristics and approved submittals with materials as received. Include factory tests and other evaluations, adjustments, and tests performed prior to shipment if applicable.
2. Service connection requirements, including configuration, size, location, and other pertinent characteristics.
3. Included optional features.
4. Delivery Receipt Check: Inspect and record physical condition of materials and equipment on delivery to Project site, including agreement with approved submittals, cleanliness, and lack of damage.

E. Installation Checks:

1. Location according to Drawings and approved Shop Drawings.
2. Configuration.
3. Compliance with manufacturers' written installation instructions.
4. Attachment to structure.
5. Access clearance to allow for maintenance, service, repair, removal, and replacement without the need to disassemble or remove other equipment or building elements. Access coordinated with other building elements and equipment, including, but not limited to, ceiling and wall access panels, in a manner consistent with OSHA fall-protection regulations and safe work practices.
6. Utility connections are of the correct characteristics, as applicable.
7. Correct labeling and identification.

F. Startup Checks:

1. Verify readiness of equipment to be energized. Include manufacturer's standard startup procedures and forms.
2. Perform and document initial operation of equipment to prove that it is installed properly and operates as intended according to manufacturer's standard startup procedures, at minimum.

G. Performance Tests:

1. Static Tests: As specified elsewhere, including, but not limited to, duct and pipe leakage tests, insulation-resistance tests, and water-penetration tests.
2. Component Performance Tests: Tests evaluate the performance of an input or output of components under a full range of operating conditions.
3. Equipment and Assembly Performance Tests: Test and evaluate performance of equipment and assemblies under a full range of operating conditions and loads.
4. System Performance Tests: Test and evaluate performance of systems under a full range of operating conditions and loads.
5. Intersystem Performance Tests: Test and evaluate the interface of different systems under a full range of operating conditions and loads.

3.3 GENERAL EXECUTION REQUIREMENTS

A. Schedule and coordinate with commissioning provider regarding the commissioning work.

B. Work with commissioning provider with Cx activities identified in construction checklists, including tests, and document results of actions as construction proceeds.

3.4 COMMISSIONING MEETINGS

A. Commissioning Authority will schedule and conduct periodic commissioning meetings as needed for the project. The purpose of these meetings is to review the status of equipment and systems installation and issue resolution. The commissioning meetings include the Contractor, the sub-contractors included but not limited to the Building Automation Contractor, Lighting Controls Contractor, Mechanical Contractor (sheet metal and hydronic), and Electrical Contractor.

B. The Contractor and their sub-contractors shall prepare a preliminary schedule for commissioning activities for use by the Commissioning Authority and shall update the schedule as appropriate. The Contractor and their sub-contractors shall notify the Commissioning Authority during the commissioning meetings when commissioning activities not yet performed or not yet scheduled will delay construction.

3.5 SEQUENCING

A. Sequencing of Commissioning Verification Activities: For a particular material, item of equipment, assembly, or system, perform the following in the order listed unless otherwise indicated:

1. Construction Checklists:

    a. Construction checklists are provided by the CxA for completion by the contractor and sub-contractors. These checklists include the following types of information:
    b. Material checks.
    c. Installation checks.

d. Startup, as appropriate. Some startups may depend on component performance. Such startup may follow component performance tests on which the startup depends.
e. Performance Tests:

1) Static tests, as appropriate.
2) Component performance tests. Some component performance tests may depend on completion of startup. Such component performance tests may follow startup.
3) System performance tests.

2. Commissioning tests are directed and witnessed by the CxA and executed by the controls sub-contractor with assistance as needed by the installing sub-contractors.

B. Before performing commissioning tests, verify that materials, equipment, assemblies, and systems are delivered, installed, started, and adjusted to perform according to Contract Documents.

C. Verify readiness of materials, equipment, assemblies, and systems by performing tests prior to performing test demonstrations. Notify Architect, CxA, and Owner if acceptable results cannot be achieved due to conditions beyond Contractor's control or responsibility.

D. Test and Balance must be completed prior to the commencement of Functional Testing. Provide a preliminary TAB report to the CxA when complete.

E. Building Automation Systems (BAS) programming and graphics must be complete prior to the commencement of Functional Testing. Controls. Contractor shall complete point to point checkout of the BAS and provide documentation indicating that the point-to-point checks have been completed. Point to point checks will be randomly reviewed by the CxA. If more than 50% of the points are not verified, the Controls Contractor shall repeat the point-to-point testing prior to the commencement of Functional Testing.

F. Prior to scheduling and execution of the performance tests, the contractor / sub-contractor may be requested to complete a Certificate of Readiness to confirm the equipment is ready to test and all punch list items have been addressed.

G. Commence tests as scheduled and after installation checks for materials, equipment, assemblies, or systems are satisfactorily completed. Tests of a particular system may proceed prior to completion of other systems, provided the incomplete work does not interfere with successful execution of test.

3.6 SCHEDULING

A. Designate a representative who shall attend a commissioning kickoff meeting and other necessary meetings scheduled by the CxA to facilitate the Commissioning process.

B. Schedule the Cx work with the commissioning provider, so one month prior to Substantial Completion all major equipment is to the installation completed, started by a manufacturer representative and all systems fully functional to allow the Test and Balance and Building

Automation Systems contractors to allow Functional Testing to be conducted and allow sufficient time for corrections if necessary, prior to building handover.

C. Test and Balance must be completed prior to the commencement of Cx Functional Testing. Provide a preliminary TAB report to the CxA when complete.

D. Building Automation Systems programming and graphics must be complete prior to the commencement of Cx Functional Testing. Controls contractor shall complete point to point checkout of the BAS and provide documentation checklist indicating that the point-to-point checks have been completed. Point to point checks will be randomly reviewed by the CxA. If more than 50% of the points are not verified, the controls contractor shall repeat the point-to-point testing prior to the commencement of Functional Testing.

E. Commissioning Schedule: Integrate commissioning activities into Construction Schedule.

1. Include detailed commissioning activities in monthly updated Construction Schedule and short-interval schedule submittals.
2. Schedule the start date and duration for the following commissioning activities/milestones that are identified by commissioning provider:

a. Submittals.
b. Preliminary operation and maintenance manual submittals.
c. Installation checks.
d. Startup, where required.
e. Performance tests.
f. Performance test demonstrations.

3. Schedule shall include a line item for each installation check, startup, and test activity specific to the equipment or systems involved.

F. Two-Week Look-Ahead Commissioning Schedule:

1. Two weeks prior to the beginning of functional tests, submit a detailed two-week look-ahead schedule. Thereafter, submit updated two-week look-ahead schedules weekly for the duration of commissioning process.
2. Two-week look-ahead schedules shall identify the date, time, beginning location, Contractor personnel required, and anticipated duration for each startup or test activity.
3. Use two-week look-ahead schedules to notify and coordinate participation of Owner's witnesses.

3.7 START-UP, PRE-FUNCTIONAL CHECKLISTS AND CERTIFICATE OF READINESS

A. Prepare a start-up plan for each piece of equipment including the following:

1. The manufacturer’s standard start-up and check out procedures copied from the installation instructions.
2. The subcontractor’s standard start-up and check out procedures.
3. The CxA and/or Owner may be present for the start-up of the equipment.

B. Respond to pre-functional checklists.

1. Pre-functional checklists provided by the CxA.
2. Checklists and procedures with specific spaces for recording and documenting the inspection of each procedure and a summary block for deficiencies and explanations.
3. Ensure that start-up and pre-functional checklists are completed on the job-site concurrent with the activities being documented. Checklists that are found to have undergone remedial documentation either off-site or after the procedures have been completed will be rejected by the CxA.
4. Submit the completed start-up checklists, reports, and equipment pre-functional checklists to the CxA for review. Note all noncompliance items on these checklists. Notify the CxA when outstanding items have been corrected.
5. Submit satisfactory completed start-up checklists to the CxA a minimum of five working days prior to the start of functional performance testing.

C. Certificate of Readiness:

1. This document will be provided by the Commissioning Authority to each Contractor as necessary and verifies the equipment has been installed in accordance of the design documents, is fully operational and ready for the functional test phase. Certify systems ready for functional performance testing on a Certificate of Readiness provided by the Commissioning Authority. The Contractor shall not permit a sub-contractor to begin Functional Testing without the signature of the Commissioning Authority, which shall be affixed to the Certificate of Readiness. The Owner and Commissioning Authority are the sole arbiters of system readiness. Costs shall be apportioned as follows:

    a. The cost for Owner personnel and the Commissioning Authority to reschedule a functional performance test, made necessary because an item certified by a signatory to the Certificate of Readiness to be ready is found incomplete or faulty, shall be charged to the responsible party.
    b. For a deficiency identified during Functional Testing, not identified during the static installation inspection, the Owner through the Commissioning Authority shall direct re-testing of the equipment once at no charge for their time. All costs for subsequent retesting shall be charged to the responsible party.
    c. Items left incomplete by a Contractor, and later causing deficiencies or delays during Functional Testing may result in back charges to the responsible party.

D. Contractor shall promptly correct deficient conditions and issues discovered during commissioning process. Costs of correcting such deficient conditions and issues, including additional testing and inspections, the cost of uncovering and replacement, and compensation for Commissioning Authority's services and expenses made necessary thereby, shall be at Contractor's expense.

E. If Architect, Commissioning Authority, other Owner's witness, or Owner's staff perform additional services or incur additional expenses due to actions of Contractor listed below, compensate Owner for such additional services and expenses.

1. Failure to provide timely notice of commissioning activities schedule changes.
2. Failure to meet acceptance criteria for test demonstrations.

F. Contractor shall compensate Owner for such additional services and expenses at the rate of $175 per labor hour, plus $1000 per round trip for personnel travelling more than 200 miles, plus per diem allowances for meals and lodging according to current U.S. General Services Administration (GSA) Per Diem Rates.

3.8 COMMISSIONING TESTING

A. Quality Control: Construction checklists, including tests, are quality-control tools designed to improve the functional quality of Project. Test demonstrations evaluate the effectiveness of Contractor's quality-control process.

B. Test Data Forms:

1. Provide all documentation as requested to the CxA for development of functional performance testing procedures. This documentation shall include, at a minimum, manufacturer’s installation, start-up, operation and maintenance procedures. The CxA may request further documentation as necessary for the development of functional performance tests.
2. Review the functional performance test scripts developed by the CxA.

    a. Respond in writing to the CxA regarding the acceptability of the proposed test scripts.
    b. Note any necessary modifications to the scripts due to the actual equipment/systems or safety concerns and submit these to the CxA for consideration.

C. Performance of Tests:

1. The sampling rate for test demonstrations is approximately 25 percent for terminal equipment and 100 percent for primary equipment unless otherwise indicated in the Commissioning Plan.
2. Accomplish the functional performance testing of equipment based on scripts developed by the CxA and as reviewed by the Contractor.

    a. Provide access to the equipment in compliance with OSHA regulations.
    b. Provide, to the CxA, access to the Building Automation System by way of passwords, web-based access, remote access, and access on site via temporary or permanent front-end computer and equipment.
    c. Provide skilled technicians to operate the systems during functional performance testing.
    d. Correct any deficiencies identified during testing and retest equipment as required.

3. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of Building Automation System controllers and sensors.
4. The CxA may direct that set points be altered when simulating conditions is not practical.
5. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

6. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
7. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.
8. False load test requirements are specified in related sections.

    a. Where false load testing is specified, provide temporary equipment, power, controls, wiring, piping, valves, and other necessary equipment and connections required to apply the specified load to the system. False load system shall be capable of steady-state operation and modulation at the level of load specified. Equipment and systems permanently installed in this work shall not be used to create the false load without Architect's written approval.

D. Non-Conformance.

1. The CxA will record the results of the functional test on the FTS form. Test results that are not within the range of acceptable results are commissioning compliance issues.
2. Corrections of minor issues of non-conformance identified may be made during the tests at the discretion of the CxA. In such cases the issues of non-conformance and resolution will be documented on the FTS form.
3. Track and report commissioning compliance issues until resolution and retesting are successfully completed.
4. As tests progress and non-conformance issues are identified, the CxA will discuss and log issues.

    a. When there is no dispute on the non-conformance issue and the Sub accepts responsibility to correct it:

        1) The CxA documents the deficiency and the Sub’s response and intentions and they go on to another test or sequence.

    b. If there is a dispute about a non-conformance issue, regarding whether it is a non-conformance issue or who is responsible:

        1) The non-conformance issue shall be documented as an issue and assigned to an assumed responsible party.
        2) Resolutions shall be made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Owner.
        3) The CxA documents the resolution process in the Issues Log.
        4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency and provides a written response in the Issues Log documenting the resolution. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved.

5. If a test demonstration fails, determine the cause of failure. The Commissioning Team shall provide timely resolution of issue and then repeat the demonstration. If a test demonstration must be repeated due to failure caused by Contractor work or materials,

the responsible Contractor will reimburse the Owner for billed costs explained previously for the participation in the repeated demonstration.

6. Test Results: If a test demonstration fails to meet the acceptance criteria, perform the following:

    a. Document the issue in the Commissioning Issue Log.
    b. Determine the cause of the failure.
    c. Establish responsibility for corrective action if the failure is due to conditions found to be Contractor's responsibility.
    d. Submit notification of issue resolution via the software platform. Retesting shall be scheduled with the CxA when corrective action has been completed.

7.
8. Provide written response to each issue recorded in the Issue Log provided by the CxA. Update these responses at least as often as commissioning meetings are being scheduled. Outline the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
9. The CxA retains the original FTS forms until the end of the project.

E. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable. In such case, the Contractor shall provide the Owner with the following:

1. Within one week of notification, the Contractor or manufacturer’s representative shall examine all other identical units making a record of the findings. The findings shall be provided within two weeks of the original notice.
2. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly differ from the specification requirements of the original installation.
3. The Owner will determine whether a replacement of all identical units or a repair is acceptable.
4. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

F. Approval: The CxA notes each satisfactorily demonstrated function recommends acceptance of each test on the FTS form. The Owner gives final approval on each test using the same form, providing a signed copy to the CxA and the Contractor.

G. Deferred Tests:

1. Deferred Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed deferred tests or other tests approved for deferral until specified seasonal or other conditions are available. When approved,

deferred tests may be completed after the date of Construction-Phase Commissioning Completion. Identify proposed deferred tests in the request for Certificate of Construction-Phase Commissioning Process Completion as follows:

a. Identify deferred tests by number and title.
b. Provide a target schedule for completion of deferred tests.

H. Commissioning Issue Log: Commissioning Issues are documented utilizing the Cx software platform.

1. Respond in writing to the issue, as a minimum, within 10 working days of its published date or the date of any subsequent comment by the CxA.
2. If work on resolving an issue is in progress, indicate this in writing.
3. Ensure the sub-contractors provide information required to solve the issue.
4. Periodically, all issues open and not responded to within 10 working days will be submitted to the Owner as delinquent. The CxA reserves sole discretion in determining the status of issues, e.g., “open”, “ready for review”, or “closed”.

I. Retest: The Commissioning Team will diagnose the items to be retested, responsible builders shall correct failed test demonstrations as follows.

1. Schedule and repeat the complete test procedure for each test demonstration for which acceptable results are not achieved. Repeat test demonstration until acceptable results are achieved. Except for issues that are determined to result from design errors or omissions, or other conditions beyond Contractor's responsibility, compensate Owner for direct costs incurred as the result of repeated test demonstrations to achieve acceptable results.
2. Perform diagnostic tests and activities required to determine the fundamental cause of issues observed.
3. Record each step of the diagnostic procedure prior to performing the procedure. Update written procedure as changes become necessary.
4. Record the results of each step of the diagnostic procedure.
5. Record the conclusion of the diagnostic procedure on the fundamental cause of the issue.
6. Determine and record corrective measures.
7. Include diagnosis of fundamental cause of issues in commissioning compliance issue report.
8. The cost for the responsible builder to retest a functional test, if they are responsible for the non-conformance issue, shall be theirs.

a. First two functional tests: The CxA shall attend and record results for up to two (2) functional tests for any given piece of equipment as part of the CxA’s normal scope.
b. Beyond two tests: The cost for the CxA’s time for attending and recording results beyond two tests shall be charged to the Contractor by Change Order when:

1) The deficiency is due to deficient work by responsible Contractors and that work has been recorded as deficient by the CxA.
2) That work remains uncorrected or the Contractor has failed to adequately respond to commissioning comments after the first two tests. Do not correct commissioning compliance issues during test demonstrations.

3) Exceptions will be allowed if the cause of the issue is obvious and resolution can be completed in less than 15 minutes. If corrections are made under this exception, note the deficient conditions on the test data form and issue a commissioning compliance issue report. A new test data form, marked "Retest," shall be initiated after the resolution has been completed.

3.9 COMMISSIONING REPORTS

A. Startup Reports: Startup test reports that are required for equipment warranty by the manufacturer shall be completed by the Contractor and sub-contractors prior to Functional Testing. These startup reports are separate from the construction checklists. Both construction checklists and start up reports shall be provided prior to Functional Testing. Startup reports include observations of the conditions of installation, organized into the following sections:

1. Equipment Received Checklist: ERC's, compare contract requirements, approved submittals, and provided equipment. Observe physical condition of equipment prior to installation. Note conditions including, but not limited to, physical damage, corrosion, water damage, or other contamination or dirt.
2. Pre-Functional Checklist: Verify components supplied with the equipment, preinstalled or field installed, are correctly installed and functional. Verify external components required for proper operation of equipment correctly installed and functional. Note missing, improperly configured, improperly installed, or nonfunctional components.
3. Summary of Installation Compliance Issues and Corrective Actions: Identify installation compliance issues and the corrective actions for each. Verify that issues noted have been corrected.
4. Evaluation of System Readiness for Startup: For each item of equipment for each system for which startup is anticipated, document in summary form acceptable to Owner completion of equipment model verification, preinstallation physical condition checks, preinstallation component verification checks, and completion of corrective actions for installation compliance issues.

B. Testing Reports:

1. Test report are included in the Cx software platform and shall be recorded utilizing the application.
2. "As-tested" system configuration. Complete record of conditions under which the test was performed, including, but not limited to, the status of equipment, systems, and assemblies; temporary adjustments and settings; and ambient conditions.
3. Data and observations, including, but not limited to, data trend logs, recorded during the tests.
4. Data trend logs accumulated overnight from the previous day of testing.

C. Periodic progress reports: include information for tests conducted since the preceding report and the following:

1. Completed data forms.
2. Equipment or system tested, including test number, system or equipment tag number and location, and notation about the apparent acceptability of results.
3. Activities scheduled but not conducted per schedule.

4. Commissioning compliance issue report log.
5. Schedule changes for remaining Commissioning-Process Work, if any.

3.10 CERTIFICATE OF CONSTRUCTION-PHASE COMMISSIONING PROCESS COMPLETION

A. When Contractor considers that construction-phase commissioning process, or a portion thereof which Owner agrees to accept separately, is complete, Contractor shall prepare and submit to Owner and Commissioning Authority through Architect a comprehensive list of items to be completed or corrected. Failure to include an item on such list does not alter Contractor's responsibility to compete commissioning process.

B. On receipt of Contractor's list, Commissioning Authority will make an inspection to determine whether the construction-phase commissioning process or designated portion thereof is complete. If Commissioning Authority's inspection discloses items, whether included on Contractor's list, which is not sufficiently complete as defined in "Construction-Phase Commissioning Process Completion" Paragraph in the "Definitions" Article, Contractor shall, before issuance of the Certificate of Construction-Phase Commissioning Process Completion, complete or correct such items on notification by Commissioning Authority. In such case, Contractor shall then submit a request for another inspection by Commissioning Authority to determine construction-phase commissioning process completion.

C. Contractor shall promptly correct deficient conditions and issues discovered during commissioning process. Costs of correcting such deficient conditions and issues, including additional testing and inspections, the cost of uncovering and replacement, and compensation for Commissioning Authority's services and expenses made necessary thereby, shall be at Contractor's expense.

3.11 WARRANTY PERIOD

A. Execute seasonal or deferred functional performance testing, witnessed by the CxA, when specified as part of the commissioning process or called for in the Commissioning Plan.

B. Correct issues of non-compliance and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

C. Ensure that Subs correct items of non-compliance and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing or the 10-month review.

END OF SECTION 019113

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Form-facing material for cast-in-place concrete.
2. Form liners.
3. Shoring, bracing, and anchoring.

1.3 DEFINITIONS

A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.

B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction, movement, contraction, and isolation joints
c. Forms and form-removal limitations.
d. Shoring and reshoring procedures.
e. Anchor rod and anchorage device installation tolerances.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following:

1. Exposed surface form-facing material.

2. Concealed surface form-facing material.
3. Form liners.
4. Form ties.
5. Waterstops.
6. Form-release agent.

B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.

    a. Location of construction joints is subject to approval of the Architect.

3. Indicate location of waterstops.
4. Indicate form liner layout and form line termination details.

C. Samples:

1. For waterstops.
2. For Form Liners: 12-inch by 12-inch sample, indicating texture.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing and inspection agency.

B. Field quality-control reports.

C. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

A. Testing and Inspection Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Form Liners: Store form liners under cover to protect from sunlight.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:

a. Plywood, metal, or other approved panel materials.
b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

1) APA HDO (high-density overlay).
2) APA MDO (medium-density overlay); mill-release agent treated, and edge sealed.
3) APA Structural 1 Plyform, B-B or better; mill oiled, and edge sealed.
4) APA Plyform Class I, B-B or better; mill oiled, and edge sealed.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for a tight fit.

C. Form Liners:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Architectural Polymers, Inc.
b. Fitzgerald Formliners.
c. Sika Corporation.
d. Spec Formliners, Inc.

2.3 WATERSTOPS

A. Flexible Rubber Waterstops: U.S. Army Corps of Engineers CRD-C 513, for embedding in concrete to prevent passage of fluids through joints, with factory fabricated corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Williams Products, Inc.

B. Flexible PVC Waterstops: U.S. Army Corps of Engineers CRD-C 572, for embedding in concrete to prevent passage of fluids through joints, with factory fabricate corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. BoMetals, Inc.
    b. Sika Corporation.
    c. Vinylex Waterstop & Accessories.

C. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. CETCO is a subsidiary of Minerals Technologies Inc.
    b. Carlisle Coatings & Waterproofing Inc.
    c. Concrete Sealants Inc.
    d. Henry Company.
    e. J P Specialties, Inc.
    f. Sika Corporation.

D. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. CETCO is a subsidiary of Minerals Technologies Inc.
    b. GCP Applied Technologies Inc.
    c. Kryton International, Inc.
    d. OCM, Inc.
    e. Sika Corporation.

2.4 RELATED MATERIALS

A. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners shall be acceptable to form liner manufacturer.

F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive damp proofing or waterproofing.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.

C. Limit concrete surface irregularities as follows:

1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips.
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

I. Chamfer exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

L. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3. Place joints perpendicular to main reinforcement.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5. Clean embedded items immediately prior to concrete placement.

3.3 INSTALLATION OF WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 033000 "Cast-In-Place Concrete."
4. Secure waterstops in correct position at 12 inches on center.
5. Field fabricate joints in accordance with manufacturer's instructions using heat welding.

    a. Miter corners, intersections, and directional changes in waterstops.
    b. Align center bulbs.

6. Clean waterstops immediately prior to placement of concrete.
7. Support and protect exposed waterstops during progress of the Work.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Protect exposed waterstops during progress of the Work.

3.4 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.

1. Align and secure joints to avoid offsets.
2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector or qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction contraction and isolation joints.
c. Steel-reinforcement installation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.
3. Mechanical splice couplers.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
3. For structural thermal break insulated connection system, indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.

C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to approval of Architect.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For testing and inspection agency.

B. Welding certificates.

1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:

a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

2. Mechanical splice couplers.

D. Field quality-control reports.

E. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

1. Store reinforcement to avoid contact with earth.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

B. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.

C. Headed-Steel Reinforcing Bars: ASTM A970/A970M.

D. Steel Bar Mats: ASTM A184/A184M, fabricated from ASTM A615/A615M, Grade 60, deformed bars, assembled with clips.

E. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

F. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

2.2 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

a. For concrete surfaces exposed to view, where legs of wire bar support contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
b. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
c. For dual-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
d. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
e. For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

C. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Plain.

2.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.

2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.
3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

G. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed 12 inches.

2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement.

2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector or qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel-reinforcement placement.
2. Steel-reinforcement mechanical splice couplers.
3. Steel-reinforcement welding.

D. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete Subcontractor.
e. Special concrete finish Subcontractor.

2. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction joints, control joints, isolation joints, and joint-filler strips.
c. Semirigid joint fillers.
d. Vapor-retarder installation.
e. Anchor rod and anchorage device installation tolerances.
f. Cold and hot weather concreting procedures.
g. Concrete finishes and finishing.
h. Curing procedures.
i. Forms and form-removal limitations.
j. Shoring and reshoring procedures.

k. Methods for achieving specified floor and slab flatness and levelness.
l. Floor and slab flatness and levelness measurements.
m. Concrete repair procedures.
n. Concrete protection.
o. Initial curing and field curing of field test cylinders (ASTM C31/C31M).
p. Protection of field cured field test cylinders.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement
7. Aggregates.
8. Admixtures:

a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.

9. Color pigments.
10. Fiber reinforcement.
11. Vapor retarders.
12. Floor and slab treatments.
13. Liquid floor treatments.
14. Curing materials.

a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.

15. Joint fillers.
16. Repair materials.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
6. Slump limit.
7. Air content.
8. Nominal maximum aggregate size.
9. Steel-fiber reinforcement content.

10. Synthetic micro-fiber content.
11. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
12. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
13. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
14. Intended placement method.
15. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

a. Location of construction joints is subject to approval of the Architect.

D. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Fiber reinforcement.
4. Curing compounds.
5. Floor and slab treatments.
6. Bonding agents.
7. Adhesives.
8. Vapor retarders.
9. Semirigid joint filler.
10. Joint-filler strips.

11. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement.
7. Aggregates.
8. Admixtures:

a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

E. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.

1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Field Quality-Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests to be qualified as an ACI Concrete Field-Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

1. Include the following information in each test report:

a. Admixture dosage rates.
b. Slump.
c. Air content.
d. Seven-day compressive strength.
e. 28-day compressive strength.
f. Permeability.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
3. Obtain aggregate from single source.
4. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I Type II Type I/II Type III.
2. Fly Ash: ASTM C618, Class C or F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C595/C595M.
5. Silica Fume: ASTM C1240 amorphous silica.
6. Performance-Based Hydraulic Cement: ASTM C1157/C1157M: .

C. Normal-Weight Aggregates: ASTM C33/C33M, coarse aggregate or better, graded. Provide aggregates from a single source.

1. Alkali-Silica Reaction: Comply with one of the following:

a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.

2. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Air-Entraining Admixture: ASTM C260/C260M.

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

F. Water and Water Used to Make Ice: ASTM C94/C94M, potable.

2.3 VAPOR RETARDERS ***<Note to Specifier: check site specific Geotech Report for radon mitigation. Confirm if testing is required to determine appropriate mitigation barrier and/or barrier thickness needed>***

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than ***<15 mils*** thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Barrier-Bac; Inteplast Group.
b. Fortifiber Building Systems Group.
c. Foxfire Enterprises, Inc.
d. ISI Building Products.
e. Poly-America, L.P.
f. Raven Industries, Inc.
g. Reef Industries, Inc.
h. Stego Industries, LLC.
i. Tex-Trude.
j. W. R. Meadows, Inc.

2.4 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dayton Superior Corporation.
b. Euclid Chemical Company (The); an RPM company.
c. Master Builders Solutions.
d. Nox-Crete Products Group.
e. SpecChem, LLC.
f. W. R. Meadows, Inc.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

a. Ambient Temperature Below 50 deg F: Black.
b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
c. Ambient Temperature Above 85 deg F: White.

D. Water: Potable or complying with ASTM C1602/C1602M.

E. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dayton Superior Corporation.
b. Euclid Chemical Company (The); an RPM company.
c. Laticrete International, Inc.
d. Nox-Crete Products Group.
e. W. R. Meadows, Inc.

F. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dayton Superior Corporation.
b. Euclid Chemical Company (The); an RPM company.
c. Laticrete International, Inc.

d. Master Builders Solutions.
e. Nox-Crete Products Group.
f. W. R. Meadows, Inc.

2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, in accordance with ASTM D2240.

C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.6 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested in accordance with ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.7 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, and concrete with a w/cm below 0.50.

2.8 CONCRETE MIXTURES

A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

1. Exposure Class: ACI 318 F2 S2 W1 C1.
2. Minimum Compressive Strength: As indicated at 28 days.
3. Maximum w/cm: As indicated.

B. Class C: Normal-weight concrete used for interior slabs-on-ground.

1. Exposure Class: ACI 318 F0 S0 W0 C0.
2. Minimum Compressive Strength: As indicated at 28 days.
3. Maximum w/cm: As indicated.
4. Air Content:

a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and furnish batch ticket information.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.4 INSTALLATION OF VAPOR RETARDER

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.
3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
4. Lap joints 6 inches and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.

    a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.5 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.

    a. Continue reinforcement across construction joints unless otherwise indicated.
    b. Do not continue reinforcement through sides of strip placements of floors and slabs.

3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

a. Do not use vibrators to transport concrete inside forms.
b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.7 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.

a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
b. Remove projections larger than 1 inch.
c. Tie holes do not require patching.
d. Surface Tolerance: ACI 117 Class D.
e. Apply to concrete surfaces not exposed to public view.

3.8 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish.

C. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic, or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:

a. Slabs on Ground:

1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch.
2) Specified overall values of flatness, F_F 25; and of levelness, F_L 20; with minimum local values of flatness, F_F 17; and of levelness, F_L 15.

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases to be the thickness required or recommended by the equipment manufacturer high unless otherwise indicated on Drawings and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place, and secure anchorage devices.

    a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    b. Cast anchor-bolt insert into bases.
    c. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.10 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305.1, before and during finishing operations.

B. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing immediately after finishing concrete.
2. Interior Concrete Floors:

    a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:

        1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than 12 inches.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
b) Cure for not less than seven days.

3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

a) Water.
b) Continuous water-fog spray.

b. Floors to Receive Curing Compound:

1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

3.11 TOLERANCES

A. Conform to ACI 117.

3.12 JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month(s).
2. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.13 CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1-part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.

a. Limit cut depth to 3/4 inch.
b. Make edges of cuts perpendicular to concrete surface.
c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
d. Fill and compact with patching mortar before bonding agent has dried.
e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.

a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
b. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

a. Correct low and high areas.
b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.

    a. Finish repaired areas to blend into adjacent concrete.

5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.

    a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    b. Feather edges to match adjacent floor elevations.

6. Correct other low areas scheduled to remain exposed with repair topping.

    a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
    b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.

    a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
    b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
    c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
    d. Place, compact, and finish to blend with adjacent finished concrete.
    e. Cure in same manner as adjacent concrete.

8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

    a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
    b. Dampen cleaned concrete surfaces and apply bonding agent.
    c. Place patching mortar before bonding agent has dried.
    d. Compact patching mortar and finish to match adjacent concrete.
    e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.14 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency to be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

    a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:

        1) Project name.
        2) Name of testing agency.
        3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
        4) Name of concrete manufacturer.
        5) Date and time of inspection, sampling, and field testing.
        6) Date and time of concrete placement.
        7) Location in Work of concrete represented by samples.
        8) Date and time sample was obtained.
        9) Truck and batch ticket numbers.
        10) Design compressive strength at 28 days.
        11) Concrete mixture designation, proportions, and materials.
        12) Field test results.
        13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
        14) Type of fracture and compressive break strengths at seven days and 28 days.

C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

D. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.

5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M:

    a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    b. Perform additional tests when concrete consistency appears to change.

3. Slump Flow: ASTM C1611/C1611M:

    a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    b. Perform additional tests when concrete consistency appears to change.

4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete.

    a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

5. Concrete Temperature: ASTM C1064/C1064M:

    a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.

6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.

    a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

7. Compression Test Specimens: ASTM C31/C31M:

    a. Cast and laboratory cure two sets of four 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.

8. Compressive-Strength Tests: ASTM C39/C39M.

a. Test one set of two laboratory-cured specimens at seven days and one set of two specimens at 28 days.
b. Test one set of two field-cured specimens at seven days and one set of two specimens at 28 days.
c. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests:

a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.

1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.6.6.3.

13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 24 hours of completion of floor finishing and promptly report test results to Architect.

3.15 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.

END OF SECTION 033000

SECTION 034500 - PRECAST ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast architectural concrete wall caps.
2. Reinforcing materials.
3. Concrete materials.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Precast architectural concrete unit design mixtures: Include compressive strength and water-absorption tests for each precast concrete mixture.
2. Reinforcing materials.
3. Concrete materials.

B. Shop Drawings:

1. Detail fabrication and installation of architectural precast concrete units.
2. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit.

C. Samples: Design reference samples for initial verification of design intent, for each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of three, representative of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver architectural precast concrete units in such quantities and at such times to limit unloading units temporarily on the ground or other rehandling.

B. Protect units to prevent contact with soil, prevent staining, and prevent cracking, distortion, warping, or other physical damage.

C. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Design Standards: Comply with ACI 318 and design recommendations of PCI MNL 120 applicable to types of architectural precast concrete units indicated.

2.2 PRECAST ARCHITECTURAL CONCRETE UNITS

A. Provide unit types as indicated on Drawings, including wall caps.

B. Fabricators: Subject to compliance with requirements, available fabricators offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Oberfields Inc. Precast Concrete Coping.

C. Color: As selected by Architect from manufacturer’s full range.

2.3 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that provides continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.

2.4 REINFORCING MATERIALS

A. Galvanized Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed bars, with ASTM A767/A767M, Class II zinc coating and chromate treatment.

2.5 CONCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type III.

B. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C33/C33M, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

C. Coloring Admixture: ASTM C979/C979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.

D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.

E. Air-Entraining Admixture: ASTM C260/C260M, certified by manufacturer to be compatible with other required admixtures.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.

B. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 or PCI MNL 117 when tested in accordance with ASTM C1218/C1218M.

C. Normal-Weight Concrete Mixtures: Proportion full-depth mixture by either laboratory trial batch or field test data methods in accordance with ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi minimum.
2. Maximum Water-Cementitious Materials Ratio: 0.45.

D. Water Absorption: Six percent by weight or 14 percent by volume, tested in accordance with ASTM C642, except for boiling requirement.

E. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.

F. When included in design mixtures, add other admixtures to concrete mixtures in accordance with manufacturer's written instructions.

2.7 FABRICATION OF MOLDS

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

B. Maintain molds to provide completed architectural precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

1. Form joints are not permitted on faces exposed to view in the finished Project.

2.8 FABRICATION OF PRECAST ARCHITECTURAL CONCRETE

A. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units, as indicated on the Drawings.

B. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.

3. Place reinforcing steel to maintain at least 3/4-inch minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.

C. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

D. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

E. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

F. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 117.

G. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.

H. Cure concrete, in accordance with PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

I. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs comply with requirements in PCI MNL 117 and Architect's approval.

2.9 FABRICATION TOLERANCES

A. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

2.10 FINISHES

A. Exposed faces to be free of joint marks, grain, and other obvious defects. Corners, including false joints to be uniform, straight, and sharp.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not install precast concrete units until supporting masonry is ready to receive precast concrete units.

3.2 INSTALLATION OF PRECAST ARCHITECTURAL CONCRETE UNITS

A. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.

3.3 ERECTION TOLERANCES

A. Erect architectural precast concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

3.4 REPAIR

A. Repair architectural precast concrete units if permitted by Architect. Architect reserves the right to reject repaired units that do not comply with requirements.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 ft.

C. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

3.5 CLEANING

A. Clean surfaces of precast concrete units exposed to view.

END OF SECTION 034500

SECTION 042200 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout materials.
3. Reinforcement.
4. Masonry-joint reinforcement.

B. Products Installed, but Not Furnished, under This Section:

1. Precast architectural concrete trim in accordance with Section 034500 "Precast Architectural Concrete" in concrete unit masonry.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

C. Exposed: Weather-exposed side of a constructed wall.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.

C. Samples for Initial Selection:

1. Architectural CMUs, in the form of small-scale units.
2. Colored mortar.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include data on material properties.

2. Integral water repellent used in CMUs, if not surface treated.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.
8. Joint reinforcement.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined in accordance with TMS 402/602.

E. Weather Procedures:

1. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.
2. Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.6 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.

B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 402/602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 402/602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

C. Source Limitations for Integral Water Repellent: Obtain integral water-repellent units from CMU and mortar manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with Tables 1 and 2 in TMS 402/602.

B. Regulatory Requirements: Comply with the provisions of the following codes, specifications, and standards, except as otherwise shown or specified:

1. TMS 402/602:

a. Maintain one copy of the standard in Project field office at all times during construction. Contractor's supervisory personnel are to be thoroughly familiar with this material as it applies to Project.

2.3 CONCRETE UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 402/602 except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

C. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for corners, movement joints, and other special conditions.
2. Provide square-edged units for outside corners unless otherwise indicated.

D. Integral Water Repellent: Surface-applied water repellent for exposed units.

1. Description: Liquid polymeric, water-repellent admixture that does not reduce flexural bond strength. Units made with water repellent, when tested in accordance with ASTM E514/E514M as a wall assembly made with mortar containing water-repellent manufacturer's mortar additive, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen.

2.4 CONCRETE MASONRY UNITS

A. Architectural CMUs: Non-load bearing, ASTM C129.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Oberfields Inc. DESIGNBLOK Split Face, or approved equal.
2. Density Classification: Normal weight.
3. Size (Width): Manufactured to dimensions 3/8 inch less-than-nominal dimensions.
4. Pattern and Texture:

    a. Standard pattern, split-face finish.

5. Colors: As selected by Architect from manufacturer's full range.

2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content is not more than 0.1 percent when tested in accordance with ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

E. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

F. Aggregate for Grout: ASTM C404.

G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

H. Water-Repellent Mortar Admixture: Liquid water-repellent admixture added to mortar, intended for use with CMUs containing integral water repellent from same manufacturer.

I. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A951/A951M.

1. Exterior Walls: Hot-dip galvanized carbon steel.
2. Wire Size for Side Rods: 0.148-inch diameter.
3. Wire Size for Cross Rods: 0.148-inch diameter.
4. Spacing of Cross Rods: Not more than 16 inches o.c.
5. Provide in lengths of not less than 10 ft., with prefabricated corner units.

2.7 TIES AND ANCHORS

A. General: Ties and anchors extend at least 1-1/2 inches into masonry but with at least a 5/8-inch cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Masonry Cleaners:

1. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength, general-purpose cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from masonry surfaces of type indicated below without discoloring or damaging masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned.

2.9 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime mortar unless otherwise indicated.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type S.
3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 402/602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
3. Provide grout with a slump of 8 to 11 inches as measured in accordance with ASTM C143/C143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that would impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

D. Exposed Masonry: Mix units to product uniform blend of colors and textures.

E. Masonry Protection: Protect completed masonry and masonry not being worked on in the following manner. Temperature ranges indicated apply to mean daily air temperatures except for grouted masonry. For grouted masonry, temperature ranges apply to anticipated minimum night temperatures.

1. 40 to 32 Deg F (4 to 0 Deg C): Protect masonry from rain or snow for at least 24 hours by covering with weather-resistive membrane.
2. 32 to 25 Deg F (0 to Minus 4 Deg C): Completely cover masonry with weather-resistive membrane for at least 24 hours.
3. 25 to 20 Deg F (Minus 4 to 7 Deg C): Completely cover masonry with weather-resistive insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.
4. 20 Deg F (Minus 7 Deg C) and Below: Except as otherwise indicated, maintain masonry temperature above 32 deg F (0 deg C) for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps or other methods proven to be satisfactory. For grouted masonry, maintain heated enclosure to 40 deg F for 48 hours.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 ft., or 1/2 inch maximum.
2. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2 inch maximum.
3. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2 inch maximum.
4. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 ft. or 1/2 inch maximum.
5. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in grouted masonry, including starting course on footings.
3. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

B. Where applicable, set masonry trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Wet joint surfaces thoroughly before applying mortar.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at corners by using prefabricated L-shaped units.

3.7 CONTROL JOINTS

A. General: Install control joint materials in CMUs as masonry progresses. Do not allow materials to span control joints without provision to allow for in-plane wall or partition movement.

B. Locate control joints. See Drawings.

C. Form control joints in CMUs as follows:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.

3.8 REINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 402/602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 402/602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.9 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as Work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid-strippable masking agent or polyethylene film and waterproof masking tape.
3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
4. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 08-04A.

3.10 MASONRY WASTE DISPOSAL

A. Excess Masonry Waste: Remove excess clean masonry waste and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel materials.
2. Shrinkage-resistant grout.
3. Prefabricated building columns.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications and other steel items not defined as structural steel.
2. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting requirements.
3. Section 133419 "Metal Building Systems" for structural steel.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Protected Zone: Structural members or portions of structural members indicated as "protected zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

D. Demand-Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic-load-resisting system, and which are indicated as "demand critical" or "seismic critical" on Drawings.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Anchor rods.
4. Threaded rods.
5. Prefabricated building columns.
6. Shop primer.
7. Shrinkage-resistant grout.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members and connections of the seismic-load-resisting system.
6. Indicate locations and dimensions of protected zones.
7. Identify demand-critical welds.
8. Identify members not to be shop primed.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint, including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand-critical welds.

D. Delegated Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data signed and sealed by the qualified professional engineer, licensed in the state of the Project, responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, fabricator, professional engineer, and testing agency.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural-steel materials, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.

F. Survey of existing conditions.

G. Source quality-control reports.

H. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).

B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector.

C. Shop-Painting Applicator Qualifications: Qualified in accordance with AISC's Sophisticated Paint or to SSPC-QP 3.

D. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1. Welders and welding operators performing work on bottom-flange, demand-critical welds are to pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G are to be considered separate processes for welding personnel qualification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.

3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.
2. ANSI/AISC 341.
3. ANSI/AISC 360.
4. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

B. Connection Design Information:

1. Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.

C. Moment Connections: Type FR, fully restrained.

D. Construction: Moment frame

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A992/A992M.

B. Channels, Angles, M-Shapes: ASTM A36/A36M.

C. Channels, Angles, S-Shapes: ASTM A36/A36M.

D. Plate and Bar: ASTM A36/A36M.

E. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B ASTM A500/A500M, Grade C structural tubing.

F. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.

1. Weight Class: As indicated.
2. Finish: Black.

G. Steel Castings: ASTM A216/A216M, Grade WCB, with supplementary requirement S11.

H. Steel Forgings: ASTM A668/A668M.

I. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with plain finish.

B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 490-1, compressible-washer type with plain finish.

C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies, consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Plain.

2.4 RODS

A. Unheaded Anchor Rods: ASTM F1554, Grade 36 ASTM F1554, Grade 55, weldable.

1. Configuration: Hooked.
2. Nuts: ASTM A563 heavy-hex carbon steel.
3. Plate Washers: ASTM A36/A36M carbon steel.
4. Washers: ASTM F436, Type 1, hardened carbon steel.
5. Finish: Plain.

B. Headed Anchor Rods: ASTM F1554, Grade 36 ASTM F1554, Grade 55, weldable, straight.

1. Nuts: ASTM A563 heavy-hex carbon steel.
2. Plate Washers: ASTM A36/A36M carbon steel.
3. Washers: ASTM F436, Type 1, hardened carbon steel.
4. Finish: Plain.

C. Threaded Rods: ASTM A36/A36M.

1. Nuts: ASTM A63 heavy-hex carbon steel.
2. Washers: ASTM F436, Type 1, hardened carbon steel.
3. Finish: Plain.

2.5 PRIMER

A. Steel Primer:

1. Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
2. SSPC-Paint 23, latex primer.
3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.6 SHRINKAGE-RESISTANT GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
4. Mark and match-mark materials for field assembly.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 1.

F. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.

H. Welded-Steel Door Frames: Build up welded-steel doorframes attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated on Drawings.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.8 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.9 SHOP PRIMING

A. Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.
2. SSPC-SP 3.

C. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.

1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
2. Bolted Connections: Inspect shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

    a. Liquid Penetrant Inspection: ASTM E165/E165M.
    b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    c. Ultrasonic Inspection: ASTM E164.
    d. Radiographic Inspection: ASTM E94/E94M.

4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:

    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.
    b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.

5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

C. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.5 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with ANSI/AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 REPAIR

A. Touchup Painting:

1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting." Section 099123 "Interior Painting."

B. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

3.7 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Bolted Connections: Inspect bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.

a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1) Liquid Penetrant Inspection: ASTM E165/E165M.
2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3) Ultrasonic Inspection: ASTM E164.
4) Radiographic Inspection: ASTM E94/E94M.

b. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

END OF SECTION 051200

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

B.

1. Exterior non-load-bearing wall framing.
2. Interior non-load-bearing wall framing exceeding height limitations of standard, nonstructural metal framing.
3. Ceiling joist framing.
4. Soffit framing.

C. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
3. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated Design Submittal: For cold-formed steel framing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Certificates: For each type of code-compliance certification for studs and tracks.

D. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

E. Research Reports:

1. For nonstandard cold-formed steel framing, post-installed anchors, and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency**,** or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Stud Manufacturers Association

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AllSteel & Gypsum Products, Inc.
2. CEMCO; California Expanded Metal Products Co.
3. ClarkDietrich.
4. Consolidated Fabricators Corp.; Building Products Division.
5. Craco Manufacturing, Inc.
6. Custom Stud.
7. Design Shapes in Steel.
8. MarinoWARE.
9. MBA Building Supplies.
10. SCAFCO Steel Stud Company.
11. Steel Construction Systems.
12. Steel Structural Systems.
13. Steeler, Inc.
14. Super Stud Building Products Inc.
15. Telling Industries.
16. The Steel Network, Inc.
17. United Metal Products, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated on Drawings.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/360 of the wall height.
b. Interior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height under a horizontal load of 5 lbf/sq. ft..

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

    a. Upward and downward movement of 1 inch

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing complies with AISI S100 and AISI S200 and ASTM C955, Section 8.

D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

A. Framing Members, General: Comply with AISI S200 and ASTM C955, Section 8 for conditions indicated.

B. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Grade:
2. Coating for Interior Applications: G60, A60 (ZF180), AZ50 (AZM150), or GF30 (ZGF90).
3. Coating for Exterior Wall and Soffit Applications: G90 or equivalent.

C. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade:
2. Coating: G60for Exterior Wall and Soffit Applications: G90 or equivalent.

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).
2. Flange Width: 1-5/8 inches

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel studs.

2. Flange Width: 1-1/4 inches.

C. Vertical Deflection Clips, Exterior: Manufacturer's standard bypass] or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. AllSteel & Gypsum Products, Inc.
b. ClarkDietrich.
c. MarinoWARE.
d. SCAFCO Steel Stud Company.
e. Simpson Strong-Tie Co., Inc.
f. Steeler, Inc.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch.
2. Flange Width: 1 inch plus the design gap for one-story structures.

E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

a. Minimum Base-Metal Thickness: 0.0329 inch.
b. Flange Width: 1 inch plus the design gap for one-story structures

2. Inner Track: Of web depth indicated, and as follows:

a. Minimum Base-Metal Thickness: 0.0428 inch.
b. Flange Width: equal to sum of outer deflection track flange width plus 1 inch.

F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.5 INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch.
2. Flange Width: 1-3/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness:
2. Flange Width: 1-1/4 inches.

C. Vertical Deflection Clips, Interior: Manufacturer's standard head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. ClarkDietrich.
b. MarinoWARE.
c. SCAFCO Steel Stud Company.
d. Simpson Strong-Tie Co., Inc.
e. Steeler, Inc.
f. The Steel Network, Inc.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch.
2. Flange Width: 1 inch plus the design gap for one-story structures.

E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

a. Minimum Base-Metal Thickness: 0.0329 inch.
b. Flange Width: 1 inch plus the design gap for one-story structures.

2. Inner Track: Of web depth indicated, and as follows:

a. Minimum Base-Metal Thickness: 0.0428 inch.
b. Flange Width: dimension equal to sum of outer deflection track flange width plus 1 inch).

F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.6 CEILING FRAMING

A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch.
2. Minimum Flange Width: 1-5/8 inches.

2.7 SOFFIT FRAMING

A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch
2. Flange Width: 1-5/8 inches, minimum.

2.8 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole-reinforcing plates.
11. Backer plates.

2.9 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

B. Anchor Bolts: ASTM F1554, Grade 36 or Grade 55, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC193, ICC-ES AC58 or ICC-ES AC308 as appropriate for the substrate.

1. Uses: Securing cold-formed steel framing to structure.
2. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
3. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).

D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.10 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780/A780M.

B. Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, non-staining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.

D. Shims: Load bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

E. Sill Sealer Gasket: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

F. Sill Sealer Gasket/Termite Barrier: Minimum 68-mil nominal thickness, self-adhering sheet consisting of 64 mils of rubberized asphalt laminated on one side to a 4-mil- thick, polyethylene-film reinforcement, and with release liner on adhesive side**;** formulated for

application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Polyguard Products, Inc.
    b.

2. Physical Properties:

    a. Peel Adhesion: 17.0 lb/in of width when tested in accordance with ASTM D412.
    b. Low-Temperature Flexibility: Pass at minus 25 deg F when tested in accordance with ASTM D146/D146M.
    c. Water Vapor Permeance: 0.05 perm maximum when tested in accordance with ASTM E96/E96M, Method B.
    d. Resistance to Termite Penetration: Comply with ICC-ES AC380.

2.11 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

    a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative errors are not to exceed minimum fastening requirements of sheathing or other finishing materials.

2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

C. Install load-bearing shims or grout between the underside of bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch (6 mm) to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sill sealer gasket at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

E. Install sill sealer gasket/termite barrier in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF EXTERIOR NONLOADBEARING WALL FRAMING

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: As required by delegated design.

C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to infill studs and anchor to building structure.

4. Connect drift clips to cold-formed steel framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at centers indicated on Shop Drawings.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION OF INTERIOR NONLOADBEARING WALL FRAMING

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: As required by designated design.

C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to studs and anchor to building structure.
4. Connect drift clips to cold-formed steel metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.

2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at centers indicated on Shop Drawings.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 INSTALLATION OF CEILING AND SOFFIT FRAMING

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.

C. Space joists not more than 2 inches from abutting walls, and as follows:

1. Joist Spacing: As indicated on Drawings.

D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.

1. Install web stiffeners to transfer axial loads of walls above.

F. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:

1. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
2. Combination Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated, and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

G. Secure joists to structural back-up to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.7 INSTALLATION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative errors are not to exceed minimum fastening requirements of sheathing or other finishing materials.

3.8 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

3.9 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.10 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.
2. Metal ladders.
3. Counter support brackets.
4. Metal gate posts.

1.2 COORDINATION

A. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Fasteners.
2. Slotted channel framing.
3. Manufactured metal ladders.
4. Counter support brackets.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Metal gate posts.
2. Metal ladders.

1.4 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

C. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: As indicated.
2. Cold-Rolled Steel: ASTM A1008/A1008M, structural steel, Grade 33; 0.0966-inch minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel.

2.2 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

2.3 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting."

B. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

2.4 FABRICATION, GENERAL

A. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with primers that comply with Section 099123 "Interior Painting."

2.6 METAL LADDERS

A. General:

1. Comply with ANSI A14.3.

B. Steel Ladders:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Cotterman Company; Steel Fixed Ladder Forward Exit, or approved equal.
2. Space siderails 16 inches apart unless otherwise indicated.
3. Siderails: Continuous 1/4 x 2 x 2 steel angle.
4. Rungs: 3/4-inch-diameter, corrugated steel bars.
5. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
6. Galvanize and prime ladders, including brackets.
7. Prime ladders, including brackets and fasteners, with primer specified in Section 099113 "Exterior Painting."

C. Metal Ladder Fall Protection: Extruded aluminum rigid rail track with mounting hardware, single cam fall arrestor, and end stop; meets or exceeds ANSI Z359.16, OSHA 1910.29(i).

1. Basis-of-Design Product: Subject to compliance with requirements, provide Industrial Safety Products; FallTech 776000, or approved equal.

D. Ladder Guard: Powder-coated steel, mounted directly over the ladder climbing rungs to prevent unauthorized use; provide with lock-open and lock-closed hasps.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Cotterman Company; Security Ladder Guard, or approved equal.
2. Length: 8 feet, unless otherwise indicated on drawings.

2.7 COUNTER SUPPORT BRACKETS

A. Flush Mounted Counter Support Brackets: Fabricated from horizontal aluminum T section and vertical aluminum L section. Vertical leg designed to attach to side of supporting stud and be concealed by gypsum board or other wall finish.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Rakks Inside Wall Mount EH Counter Support Bracket, or approved equal.
2. Size: As recommended by manufacturer for counter size indicated on drawings.
3. Load Capacity: 330 lb. per bracket.
4. Finish: As selected by Architect from manufacturer’s full range.

2.8 METAL GATE POSTS

A. Fabricate metal gate posts from Schedule 40 steel pipe.

2.9 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.10 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with primers specified in Section 099113 "Exterior Painting.".

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.2 INSTALLATION OF METAL LADDERS

A. Secure ladders to adjacent construction with manufacturer-provided brackets in accordance with approved shop drawings.

3.3 INSTALLATION OF METAL GATE POSTS

A. Anchor gate posts in place with concrete footings. Center and align gate posts in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace gate posts in position until concrete has cured.

B. Fill gate posts solidly with concrete, mounding top surface to shed water.

3.4 REPAIRS

A. Galvanized Surfaces: Clean abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood blocking and nailers.
2. Plywood panels.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal or greater size but less than 5 inches nominal size in least dimension.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Post-installed anchors.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

2. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.
3. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat items indicated on Drawings, and the following:

1. Concealed blocking.
2. Plywood panels.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

C. Concealed Boards: 15 percent maximum moisture content of any species.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 PLYWOOD PANELS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products specified on the Finish Schedule.

B. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

B. Screws for Fastening to Metal Framing: ASTM C1002, length as recommended by screw manufacturer for material being fastened.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC58 or ICC-ES AC308 as appropriate for the substrate.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Install plywood panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

E. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

G. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

H. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
2. ICC-ES evaluation report for fastener.

I. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILER

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

3.3 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 064116 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad architectural cabinets.
2. Cabinet hardware and accessories.
3. Miscellaneous materials.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 061053 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.

1.2 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Show large-scale details.
3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
5. Apply AWI Quality Certification Program label to Shop Drawings.

C. Samples: For each exposed product and for each color and texture specified, in manufacturer's or manufacturer's standard size.

D. Samples for Verification: For the following:

1. Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.

a. Provide one sample applied to core material with specified edge material applied to one edge.

2. Thermally Fused Laminate (TFL) Panels: 8 by 10 inches, for each color, pattern, and surface finish.

a. Provide edge banding on one edge.

3. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and Installer.

B. Product Certificates: For each type of product.

1.6 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.7 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.

B. Installer Qualifications: Manufacturer of products.

C. Mockups: Build in-place mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of typical architectural cabinets as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation

areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.9 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of paneling, wood-veneer-faced architectural cabinets, and wood trim.

2.2 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.

1. Provide labels and certificates from AWI certification program indicating that woodwork complies with requirements of grades specified.
2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.

B. Architectural Woodwork Standards Grade: Premium.

C. Type of Construction: Frameless.

D. Door and Drawer-Front Style: Flush overlay.

E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.

F. Laminate Cladding for Exposed Surfaces:

1. Basis-of-Design Product (PLAM-1): Subject to compliance with requirements, provide products specified on the Finish Schedule.
2. Horizontal Surfaces: Grade HGS.
3. Vertical Surfaces: Grade VGS.
4. Edges: ABS edge banding, 2 mm minimum thickness, matching laminate in color, pattern, and finish.

    a. Basis-of-Design Product: Subject to compliance with requirements, provide Egger ABS Edge Banding, or approved equal.

G. Materials for Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: Thermally fused laminate panels.

    a. Edges of Thermally Fused Laminate Panel Shelves: PVC or polyester edge banding.
    b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.

2. Drawer Sides and Backs: Solid-hardwood lumber.
3. Drawer Bottoms: Hardwood plywood.

H. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

I. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

J. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated on drawings.

2.3 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
2. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.4 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets.

B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 170 degrees of opening.

C. Edge Pulls: Stainless steel back-mounted pull; 6-inch length.

1. Basis-of-Design Product: Subject to compliance with requirements, provide EPCO; DP-41-AS-6, or approved equal.

D. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.

E. Drawer Slides: ANSI/BHMA A156.9.

1. Standard Duty (Grade 1 and Grade 2): Side mount.
2. Heavy-Duty (Grade 1HD-100 and Grade 1HD-200): Side mount.

    a. Type: Full extension.
    b. Material: Stainless steel slides.

3. Pencil drawers not more than 3 inches high and not more than 24 inches wide, provide 50 lb. load capacity.
4. General-purpose drawers more than 3 inches high, but not more than 6 inches high and not more than 24 inches wide, provide 75 lb. load capacity.
5. File drawers more than 6 inches high or more than 24 inches wide, provide 100 lb. load capacity.
6. Lateral file drawers more than 6 inches high and more than 24 inches but not more than 30 inches wide, provide 150 lb. load capacity.
7. Lateral file drawers more than 6 inches high and more than 30 inches wide, provide 200 lb. load capacity.

F. Door Locks: ANSI/BHMA A156.11, E07121.

G. Drawer Locks: ANSI/BHMA A156.11, E07041.

H. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.

I. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.

1. Satin Stainless Steel: ANSI/BHMA 630.

J. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.5 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

2.6 FABRICATION

A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.

B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.

B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.

C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.

D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.

1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean cabinets on exposed and semiexposed surfaces.

END OF SECTION 064116

SECTION 066400 - PLASTIC PANELING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic sheet paneling.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For plastic paneling and trim accessories, in manufacturer's standard sizes.

1.3 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain plastic paneling and trim accessories from single manufacturer.

2.2 PLASTIC SHEET PANELING

A. Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D5319.

1. Basis-of-Design Product (FRP-1, FRP-2): Subject to compliance with requirements, provide products specified on the Finish Schedule.
2. Surface-Burning Characteristics: As follows when tested by a qualified testing agency in accordance with ASTM E84. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

2.3 ACCESSORIES

A. Trim Accessories: Manufacturer's standard one-piece vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.

1. Color: Match panels.

B. Adhesive: As recommended by plastic paneling manufacturer.

C. Sealant: Mildew-resistant, single-component, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.

B. Clean substrates of substances that could impair adhesive bond, including oil, grease, dirt, and dust.

C. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.

D. Lay out paneling before installing. Locate panel joints to provide equal panels at ends of walls not less than half the width of full panels.

1. Mark plumb lines on substrate at trim accessory locations for accurate installation.
2. Locate trim accessories to allow clearance at panel edges according to manufacturer's written instructions.

3.3 INSTALLATION

A. Install plastic paneling according to manufacturer's written instructions.

B. Install panels in a full spread of adhesive.

C. Install trim accessories with adhesive.

D. Fill grooves in trim accessories with sealant before installing panels, and bed inside corner trim in a bead of sealant.

E. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION 066400

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board insulation.
2. Glass-fiber blanket insulation.
3. Thermal insulation and moisture control system for metal buildings.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Extruded polystyrene foam-plastic board insulation.
2. Glass-fiber blanket insulation.
3. Thermal insulation and moisture control system for metal buildings.

B. Shop Drawings: For thermal insulation and moisture control system for metal buildings, provide shop drawings that indicate the following:

1. Liner fabric layout.
2. Insulation layout and cut list.

1.3 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.

1. Sign, date, and post the certification in a conspicuous location on Project site.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

A. Extruded Polystyrene Board Insulation, Type VI: ASTM C578, Type VI, 40-psi minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. DuPont de Nemours, Inc.
b. Owens Corning.
c. The Dow Chemical Company.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.2 GLASS-FIBER BLANKET INSULATION

A. Glass-Fiber Blanket Insulation, Unfaced: ASTM C665, Type I; passing ASTM E136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Certainteed; SAINT-GOBAIN.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Owens Corning.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

B. Glass-Fiber Blanket Insulation, Polypropylene-Scrim-Kraft Faced: ASTM C665, Type II (nonreflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Certainteed; SAINT-GOBAIN.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Owens Corning.

2. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.3 THERMAL INSULATION AND MOISTURE CONTROL SYSTEM FOR METAL BUILDINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Bay Insulation Systems; Skyliner Insulation System, or approved equal.

B. Materials:

1. Unfaced light density fiberglass metal building insulation in one of the following product categories:

a. Metal Building Insulation:

1) Complies with ASTM C991 Type 1.
2) Complies with NAIMA 202-96-REV 2000.
3) Flame Spread Index <25 and Smoke Developed Index <50 when tested in accordance with ASTM E84, NFPA 255 and UL 723.
4) Certified by SCS Global Services to contain a minimum of 65 percent recycled glass content, 18 percent pre-consumer and 47 percent post-consumer.
5) Thermal Resistance: As indicated on drawings.
6) Unfaced.
7) GREENGUARD Indoor Air Quality Certified.
8) GREENGUARD Gold Certified.

b. Metal Building Filler Blanket Insulation:

1) Flame Spread Index <25 and Smoke Developed Index <50 when tested in accordance with ASTM E84, NFPA 255 and UL 723.
2) Certified by SCS Global Services to contain a minimum of 65 percent recycled glass content, 18 percent pre-consumer and 47 percent post-consumer.
3) Thermal Resistance: As indicated on drawings.
4) Unfaced.

5) GREENGUARD Indoor Air Quality Certified.
6) GREENGUARD Gold Certified.

2. Fabric liner facing/vapor barrier composed of woven high-density polyethylene coated on both sides with polyethylene. Complies with the following:

a. ASTM C1136, Types I through VI.

1) Type 1-IV exception for dimensional stability (value is <2.0 percent).

b. Perm rating: 0.02 or 0.03 when tested in accordance with ASTM E96 Procedure A.
c. Flame Spread Index < 25 and Smoke Developed Index < 50 when tested in accordance with ASTM E 84.
d. Color: Bright White, Sky Blue Backing

3. Vapor Barrier Adhesive: Provided by manufacturer.

a. Contact adhesive.
b. Pressure sensitive adhesive.

4. Double Sided Vapor Barrier Tape: Provided by manufacturer.

a. Width: 2-inch.

5. Patch Tape. Provided by manufacturer.
6. Metal Banding/Straps: Provided by manufacturer.

a. Size: 1-inch x 0.023 continuous length metal banding.
b. Exposed color to match vapor barrier.

7. Thermal Breaks: Thermal spacer blocks.

1) Extruded or expanded polystyrene.
2) Minimum width 3.0 inch.
3) Thickness 0.5 inch to 1.0 inch.

8. Fasteners and Clips: Provided by manufacturer.

a. Safety Clip System, to include offset clip + fastener + banding, 16 inches either side of each frame. (Required for fall protection installation.)
b. Tek 2 and Tek 4.5.

9. Insulation Hangers: Provided by manufacturer.

2.4 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.

2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Install insulation with manufacturer's R-value label exposed after insulation is installed.

D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF SLAB INSULATION

A. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.4 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..
2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.5 INSTALLATION OF THERMAL INSULATION AND MOISTURE CONTROL SYSTEM FOR METAL BUILDINGS

A. Examine the areas and conditions under which work of this section will be installed. Verify that adjacent materials are dry and ready to receive insulation. Verify structure, bracing, and concealed building systems have been tested and inspected.

B. Provide written report listing conditions detrimental to performance of work in this section. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. Install liner system in accordance with manufacturer’s installation instructions and approved shop drawings.

D. Purlin and girt attachment surfaces should be clean and dry prior to attaching two-faced tape or sealing adhesive.

E. Installed fiberglass insulation should fit snugly against purlin and girt walls in the cavity space. Avoid gaps, voids, and any excess compression.

F. Clean dirt from vapor barrier fabric using a soft cloth with soap and water or non-abrasive household cleaner. Solvent-based cleaners and abrasive pads should be avoided.

3.6 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 074213.13 - FORMED METAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exposed-fastener, lap-seam metal wall panels.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 074213.19 “Insulated Metal Wall Panels” for insulated-core metal wall backup panel system

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

C. Samples: For each type of metal panel indicated.

1.4 WARRANTY

A. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 EXPOSED-FASTENER, LAP-SEAM METAL WALL PANELS

A. Provide factory-formed metal panels designed to be field assembled by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Include accessories required for installation.

B. Tapered-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with raised, trapezoidal major ribs, installed by lapping edges of adjacent panels.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Western States Metal Roofing; Western Rib 7.2 Panel, or approved equal
2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Nominal Thickness: 22 gauge.
b. Finish: Two-coat fluoropolymer; both sides of panel.
c. Color: To match building color selected by Architect.

3. Major-Rib Spacing: 7.2 inches o.c.
4. Panel Coverage: 36 inches.
5. Panel Height: 1.5 inches.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise

indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary for a complete metal wall panel system installation.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

2.4 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.5 FINISHES

A. Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat.

PART 3 - EXECUTION

3.1 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.2 INSTALLATION

A. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.

1. Lap ribbed or fluted sheets one full rib. Apply panels and associated items true to line for neat enclosure.
2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
5. Flash panels with closures at perimeter of all openings.

B. Accessory Installation: Install accessories with positive anchorage to building, and provide for thermal expansion. Coordinate installation with flashings and other components.

C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

3.3 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION 074213.13

SECTION 074213.19 - INSULATED METAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Laminated-insulation-core metal wall panels.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 133419 “Metal Building Systems.”

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, metal building systems manufacturer, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal panel assembly during and after installation.
8. Review procedures for repair of metal panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings: Provided by insulated metal panel manufacturer.

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.
3. Locations and type of sealants.
4. Installation sequence.
5. Coordination Drawings: Provide elevation drawings and building sections which show panels in relationship to required locations for structural support as well as exterior wall finish material. Include panel details, details showing attachment to structural support, and details showing flashing and trim that continue through to exterior finish material.
6. Other details as may be required for a weathertight installation.

C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

D. Analysis Data: For insulated metal wall panels, including analysis data signed and sealed by the manufacturer’s qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample Warranties: For special warranties.

D. Manufacturer Erection Instructions: Provide manufacturer’s written installation instructions including proper material storage, material handling, installation sequence, panel location(s), and attachment methods, details and required trim and accessories.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate metal panel installation with metal building systems work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including rupturing, cracking, or puncturing.
   b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of First Day of Business (FDOB).

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E72:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 20 lbf/sq. ft.

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 20 lbf/sq. ft.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Fire-Test-Response Characteristics: Provide metal wall panels and system components with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

1. Surface-Burning Characteristics: Provide wall panels with a flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E84.

2.2 LAMINATED-INSULATION-CORE METAL WALL PANELS

A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and core material laminated or otherwise securely bonded to facing sheets during fabrication without use of contact adhesives, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.

B. Wrapped-Edge, Laminated-Insulation-Core Metal Wall Panels: Formed with flush exterior panel facing wrapped over panel edges; fasteners and attachment clip completely concealed within the joint; with gasketed joints.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Kingspan Insulated Panels, Inc.; KS Series, or comparable product by one of the following:

a. Metl-Span; CF Santa Fe.

2. Metallic-Coated Steel Sheet: Facings of zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Nominal Thickness: 22 gauge.
b. Exterior Finish: Two-coat fluoropolymer.

1) Color: As selected by Architect from manufacturer's full range.

c. Interior Finish: Siliconized polyester.

3. Core Material: Board insulation of the following type:

a. Polyisocyanurate Insulation: Closed cell, modified polyisocyanurate foam using a non-CFC blowing agent, board type, with a maximum flame-spread index of 25 and a smoke-developed index of 450.

1) Closed-Cell Content: 90 percent when tested according to ASTM D6226.

4. Clips: Manufacturer's standard one piece, formed from stainless steel.
5. Gaskets: Extruded, dry seal silicone.
6. Sealant: As recommended by manufacturer.
7. Panel Thickness: As required to achieve minimum R-value as indicated on drawings.
8. Thermal-Resistance Value (R-Value): As indicated on drawings, and according to ASTM C1363.

2.3 MISCELLANEOUS MATERIALS

A. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or

premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

B. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

C. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

D. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking, and that installation is within flatness tolerances required by metal wall panel manufacturer.

    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.3 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal wall panel manufacturer.

1. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.4 INSULATED METAL WALL PANEL INSTALLATION

A. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.

1. Install metal wall panels in accordance with manufacturer’s installation guidelines and recommendations.
2. Install panels plumb, level, and true-to-line to dimensions and layout indicated on approved shop drawings.
3. Cut panels prior to installing, where indicated on shop drawings, using a power circular saw with fine tooth carbide tip blade per manufacturer’s instructions.
4. Fasten foamed-insulation-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
5. Apply panels and associated items true to line for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.

B. Laminated-Insulation-Core Metal Wall Panels:

1. Place panel fasteners through pre-punched holes in attachment clips, concealed within the joint of the panel. Secure units to the structural supports. Space clips as recommended by manufacturer or otherwise indicated on the approved shop drawings.

C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.

B. Metal wall panels will be considered defective if they do not pass test and inspections.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213.19

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall sheet metal fabrications.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
3. Section 074213.19 “Insulated Metal Wall Panels” for sheet metal flashing and trim integral with metal wall panels.
4. Section 077100 "Roof Specialties" for manufactured roof-edge drainage systems.

1.2 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review requirements for insurance and certificates if applicable.
3. Review sheet metal flashing observation and repair procedures after flashing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following

1. Elastomeric sealant.
2. Butyl sealant.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.

2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of connections to adjoining work.
8. Detail formed flashing and trim at scale of not less than 3 inches per 12 inches.

C. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

B. Special warranty.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. Mockups: Build in-place mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical wall opening flashing.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.9 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 coating designation; prepainted by coil-coating process to comply with ASTM A755/A755M.

1. Surface: Smooth, flat.
2. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Color: Custom to match Architect's sample.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.

1. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

2.4 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

G. Do not use graphite pencils to mark metal surfaces.

2.5 WALL SHEET METAL FABRICATIONS

A. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch-high, end dams. Fabricate from the following materials:

1. Galvanized Steel: 0.022 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
6. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
7. Do not field cut sheet metal flashing and trim by torch.
8. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by

painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.

a. Embed hooked flanges of joint members not less than 1 inch into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.

1) Do not install sealant-type joints at temperatures below 40 deg F.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.3 INSTALLATION OF WALL FLASHINGS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.4 INSTALLATION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.5 CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean off excess sealants.

3.6 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

SECTION 077100 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof-edge drainage systems.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
3. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
4. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

C. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof specialties.

1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
2. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
4. Detail termination points and assemblies, including fixed points.

5. Include details of special conditions.

C. Samples: For each type of roof specialty and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Certificates: For each type of roof specialty.

C. Sample Warranty: For manufacturer's special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.5 MOCKUPS

A. Build in-place mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical roof edge, including gutter and downspout, approximately 10 feet long, including supporting construction, seams, attachments, underlayment, and accessories.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication and indicate measurements on Shop Drawings.

B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.8 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 ROOF-EDGE DRAINAGE SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide SAF (Southern Aluminum Finishing Company, Inc.); Designer Series Contemporary Profile, or comparable product by one of the following:

1. ATAS International, Inc.
2. Metal-Era, Inc.

B. Gutters: Manufactured in uniform section lengths not exceeding 12 feet, with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.

1. Aluminum Sheet: 0.040 inch thick.
2. Gutter Profile: As indicated on drawings.
3. Applied Fascia Cover (Concealed Gutter): Exposed, formed aluminum, 0.040 inch thick, with factory-mitered corners, ends, and concealed splice joints.

a. Manufacture fascia splices from 0.040-inch aluminum, 6-inch lengths, formed to fit the inside of the snap-on fascia.

4. Corners: Factory mitered and continuously welded.
5. Gutter Supports: Heavy-duty concealed gutter brackets and straps.

    a. Material: Aluminum, 0.125 inch thick.

C. Downspouts: Plain rectangular complete with elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Extruded Aluminum: 0.125 inch thick.

D. Aluminum Finish: Two-coat fluoropolymer.

1. Color: As selected by Architect from manufacturer's full range.

2.3 MATERIALS

A. Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

B. Aluminum Extrusions: ASTM B221, alloy and temper recommended by manufacturer for type of use and finish indicated.

2.4 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: ASTM D1970/D1970M; stable after testing at 240 deg F.
2. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F.

2.5 MISCELLANEOUS MATERIALS

A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:

1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
2. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.

B. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

C. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Coil-Coated Aluminum Sheet Finishes:

1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

E. Aluminum Extrusion Finishes:

1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

3.3 INSTALLATION, GENERAL

A. Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise indicated on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.

F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

3.4 INSTALLATION OF ROOF-EDGE DRAINAGE SYSTEMS

A. Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 30 inches apart. Attach ends according to manufacturer’s recommendations to make watertight. Slope to downspouts.

1. Install gutter with expansion joints at locations indicated but not exceeding 40 feet apart. Install expansion-joint caps.

C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c.

1. Connect downspouts to underground drainage system indicated.

3.5 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

C. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100

SECTION 077253 - SNOW GUARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pad-type, seam-mounted metal snow guards.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

C. Samples:

1. Pad-Type Snow Guards: Full-size unit with installation hardware.

a. For units with factory-applied finishes, submit specified color.

D. Analysis Reports: For snow guards, include analysis reports signed and sealed by the manufacturer’s qualified professional engineer responsible for their preparation.

1. Include calculation of number and location of snow guards.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed, and adhesive cured, according to adhesive manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Manufacturer’s Engineered Snow Retention System: Snow guards, including attachment to roofing material and roof deck, as applicable for attachment method, based on the following:

1. Roof snow load.
2. Snow drifting
3. Roof slope.
4. Roof type.
5. Roof dimensions.
6. Roofing substrate type and thickness.
7. Snow guard type.
8. Snow guard fastening method and strength.
9. Snow guard spacing.
10. Coefficient of Friction Between Snow and Roof Surface: 0.
11. Factor of Safety: 2.

B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Snow Loads: As indicated on Drawings.

2.2 PAD-TYPE SNOW GUARDS

A. Pad-Type, Seam-Mounted Metal Snow Guards:

1. Basis-of-Design Product: Subject to compliance with requirements, provide TRA Snow & Sun, Decoguard Clamp-On Mushroom Wide, or approved equal.
2. Material:

   a. ASTM A36 zinc-doated steel; 3/16-inch thick.
   b. Finish: Manufacturer’s standard powder coat, custom color to match metal roof.

3. Attachment: Manufacturer's tested system, capable of resisting design loads.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.

1. Space rows as indicated on approved Shop Drawings.

B. Attachment for Standing-Seam Metal Roofing:

1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
2. Pad-Type, Seam-Mounted Snow Guards:

a. Install snow guards in straight rows.
b. Secure in place using stainless steel set screws, incorporating round nonpenetrating point.
c. Torque set screw according to manufacturer's instructions.

END OF SECTION 077253

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 078443 "Joint Firestopping" for joints in or between fire-resistance-rated construction.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.

1) UL in its online directory "Product iQ."
2) Intertek Group in its "Directory of Building Products."
3) FM Approvals in its "Approval Guide."

2.3 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. 3M Fire Protection Products.
    b. A/D Fire Protection Systems Inc.
    c. Hilti, Inc.
    d. Specified Technologies, Inc.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.

1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.

C. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.

D. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.4 FILL MATERIALS

A. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

B. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

C. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

D. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

E. Intumescent Wrap Strips: Single-component intumescent elastomeric strips for use around combustible penetrants.

F. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

G. Pillows/Bags: Compressible, removable, and reusable intumescent pillows encased in fire-retardant polyester or glass-fiber cloth. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

H. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

I. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

J. Fire-Rated Cable Sleeve Kits: Complete kits designed for new or existing cable penetrations through walls to accept standard accessories.

K. Thermal Wrap: Flexible protective wrap tested and listed for up to 2-hour fire ratings in accordance with ASTM E814/UL 1479 for membrane penetrations or ASTM E1725/UL 1724 for thermal barrier and circuit integrity protection.

L. Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.

M. Retrofit Device for Cable Bundles: Factory-made, intumescent, collar-like device for firestopping existing over-filled cable sleeves and capable of being installed around projecting sleeves and cable bundles.

N. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.

O. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use around rectangular steel HVAC ducts without fire dampers.

P. Firestop Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.

Q. Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to 1/2 inch diameter.

R. Endothermic Wrap: Flexible, insulating, fire-resistant, endothermic wrap for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines.

2.5 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of First Day of Business (FDOB). If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 078443 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with Listed System Designs published by a qualified testing agency.

1) UL in its online directory "Product iQ."
2) Intertek Group in its "Directory of Building Products."

2.3 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

1. Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.
2. Provide products that, upon curing, do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
3. Provide firestop products that do not contain ethylene glycol.

B. Intumescent Gypsum Wall Framing Gaskets (Applied to Steel Tracks, Runners and Studs prior to Framing Installation): Provide products with fire, smoke, and acoustical ratings that allow movement up to 100 percent compression and/or extension in accordance with UL 2079 or ASTM E1966; have an L Rating less than 1 cfm/ft. in accordance with UL 2079; and a minimum Sound Transmission Class (STC) rating of 56 in accordance with ASTM E90 or ASTM C919.

C. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.

1. ~~Basis-of-Design Product: Subject to compliance with requirements, provide products specified on the Finish Schedule.~~
2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

D. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

2.4 ACCESSORIES

A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing joint firestopping systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Apply a suitable bond-breaker to prevent three-sided adhesion in applications where this condition occurs, such as the intersection of a gypsum wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track.

3.3 INSTALLATION

A. General: Install joint firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:

1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. from end of wall and at intervals not exceeding 30 ft.

B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2393.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of First Day of Business (FDOB). If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

END OF SECTION 078443

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonstaining silicone joint sealants.
2. Urethane joint sealants.
3. Mildew-resistant joint sealants.
4. Butyl joint sealants.
5. Latex joint sealants.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 079219 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Joint sealants.
2. Joint sealant backing materials.

B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Laboratory Test Reports: For each joint sealant and substrate material to be tested from sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

B. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.

C. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Manufacturers' special warranties.

B. Installer's special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer. Installer shall be a specialist in the application of sealants, with minimum five years of experience.

B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.7 MOCKUPS

A. Install sealant in in-place mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.8 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.9 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of First Day of Business (FDOB).

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of First Day of Business (FDOB).

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer for each sealant type.

2.2 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

1. Basis-of-Design: Subject to compliance with requirements, provide Pecora 890NST, or equivalent products by one of the following:

    a. BASF Corp. - Construction Chemicals.
    b. Tremco.
    c. Sika Corporation; Joint Sealants.

2.4 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, provide Tremco Incorporated Vulkem 116, or equivalent products by one of the following:

    a. BASF Corp. - Construction Chemicals.
    b. Pecora Corporation.
    c. Sika Corporation; Joint Sealants.

B. Urethane, S, P, 100/50, T: Single-component, pourable, plus 100 percent and minus 50 percent movement capability, traffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 100/50, Use T.

1. Manufacturers: Subject to compliance with requirements, provide Tremco Incorporated Vulkem 45 SSL, or equivalent products by one of the following:

    a. BASF Corp. - Construction Chemicals.
    b. Pecora Corporation.
    c. Sika Corporation; Joint Sealants.

2.5 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Tremco Incorporated Tremsil 200 Sanitary, or comparable product by one of the following:

    a. GE Construction Sealants; Momentive Performance Materials Inc.
    b. Pecora Corporation.
    c. The Dow Chemical Company.

2.6 BUTYL JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.

1. Manufacturers: Subject to compliance with requirements, provide Tremco Incorporated Tremflex 834, or comparable product by one of the following:

a. Bostik, Inc.
b. Pecora Corporation.

2.7 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Pecora Corporation.
b. Sherwin-Williams Company (The).
c. Tremco Incorporated.

2.8 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.9 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

1. If any joint or space cannot be put into proper condition to receive the material by specified methods, immediately notify the Architect in writing, or assume responsibility for and rectify unsatisfactory results from improper application.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean, porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

a. Concrete.
b. Unglazed surfaces of ceramic tile.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

a. Metal.
b. Glass.
c. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or

by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Time and Temperature Requirements: Apply sealants as late as possible in the construction, preceding painting, and following cleaning operations. Do not apply sealants when air temperature is below 40 degrees F.

D. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

F. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
4. Provide flush joint profile at locations indicated on Drawings in accordance with Figure 8B in ASTM C1193.
5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings in accordance with Figure 8C in ASTM C1193.

a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

a. Extent of Testing: Test completed and cured sealant joints as follows:

1) Perform 10 tests for the first 1000 ft. of joint length for each kind of sealant and joint substrate.
2) Perform one test for each 1000 ft. of joint length thereafter or one test per each floor per elevation.

b. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.

1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

c. Inspect tested joints and report on the following:

1) Whether sealants filled joint cavities and are free of voids.
2) Whether sealant dimensions and configurations comply with specified requirements.
3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.

e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

2. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

C. Prepare test and inspection reports.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of First Day of Business (FDOB). If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

1. Joint Locations:

    a. Isolation and contraction joints in cast-in-place concrete slabs.
    b. Tile control and expansion joints.
    c. Joints between different materials listed above.
    d. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, P, 100/50, T.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

    a. Construction joints in cast-in-place concrete.
    b. Joints between metal panels.
    c. Joints between different materials listed above.
    d. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
    e. Control and expansion joints in ceilings and other overhead surfaces.
    f. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, nonstaining, S, NS, 100/50, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:

    a. Isolation joints in cast-in-place concrete slabs.
    b. Control and expansion joints in tile flooring.
    c. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, P, 100/50, T.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

    a. Control and expansion joints on exposed interior surfaces of exterior walls.
    b. Tile control and expansion joints.
    c. Vertical joints on exposed surfaces of unit masonry walls.
    d. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.

1. Joint Locations:

    a. Control joints on exposed interior surfaces of exterior walls.
    b. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
    c. Other joints as indicated on Drawings.

2. Joint Sealant: Acrylic latex.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

    a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
    b. Tile control and expansion joints where indicated.
    c. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

G. Joint-Sealant Application: Concealed mastics.

1. Joint Locations:

a. Aluminum thresholds.
b. Sill plates.
c. Other joints as indicated on Drawings.

2. Joint Sealant: Butyl-rubber based.

END OF SECTION 079200

SECTION 079219 - ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acoustical joint sealants.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 079200 "Joint Sealants" for elastomeric, latex, and butyl-rubber-based joint sealants for non-acoustical applications.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Acoustical joint sealants.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants, showing full range of available colors for each product exposed to view.

C. Acoustical Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.3 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each type of acoustical joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Manufacturers' special warranties.
2. Installer's special warranties.

1.5 WARRANTY

A. Installer's Special Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of First Day of Business (FDOB).

B. Manufacturer's Special Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 ACOUSTICAL JOINT SEALANTS

A. Acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies in accordance with ASTM E90.

B. Acoustical Sealant for Exposed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834.

1. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

C. Acoustical Sealant for Concealed Joints: Manufacturer's standard nonsag, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber acoustical sealant.

2.2 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by acoustical joint-sealant manufacturer where required for adhesion of sealant to joint substrates.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where recommended by acoustical joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.

B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C919, ASTM C1193, and manufacturer's written instructions for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of acoustical joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of First Day of Business (FDOB). If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079219

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.3 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door type.

2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.

C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly and thermally rated door assemblies for tests performed by a qualified testing agency indicating compliance with performance requirements.

C. Field quality control reports.

1.7 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.8 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies is to meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

B. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.40 deg Btu/F x h x sq. ft. when tested in accordance with ASTM C1363 or ASTM E1423.

2.2 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B..

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches.
c. Face: Uncoated steel sheet, minimum thickness of 0.042 inch.
d. Edge Construction: Model 2, Seamless.
e. Edge Bevel: Bevel lock and hinge edges 1/8 inch in 2 inches.
f. Core: Manufacturer's standard.
g. Fire-Rated Core: Manufacturer's standard vertical steel stiffener core for fire-rated doors.

2. Frames:

   a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
   b. Construction: Knocked-down.

3. Exposed Finish: Prime.

2.3 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.

1. Doors:

   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 1-3/4 inches.
   c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum A60 coating.
   d. Edge Construction: Model 2, Seamless.
   e. Edge Bevel: Bevel lock and hinge edges 1/8 inch in 2 inches.
   f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
   g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
   h. Core: Polyurethane.

2. Frames:

   a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
   b. Construction: Full profile welded.

3. Exposed Finish: Prime.

2.4 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.

3. Postinstalled Expansion Anchor: Minimum 3/8-inch-diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot dip galvanized in accordance with ASTM A153/A153M, Class B.

2.5 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

C. Inserts, Bolts, and Fasteners: Hot dip galvanized in accordance with ASTM A153/A153M.

D. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

E. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

F. Glazing: Comply with requirements in Section 088000 "Glazing."

2.6 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate knocked-down frames unless otherwise indicated. Where welded frames are indicated, fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.

2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

4. At knocked-down frames, provide flush corner joints with steel reinforcing gussets and integral concealed tabs and slots which securely interlock upon assembly. Assembled corner joint shall provide tight mitered joints with flush faces.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with square stops unless otherwise indicated.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.7 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

    a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
    b. Install frames with removable stops located on secure side of opening.

2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

4. Solidly pack mineral-fiber insulation inside frames.
5. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.

2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.

D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 REPAIR

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Five-ply flush wood veneer-faced doors for transparent finish.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Requirements:

1. Section 088000 "Glazing" for glass view panels in flush wood doors.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Door core materials and construction.
2. Door edge construction
3. Door face type and characteristics.
4. Door trim for openings.
5. Factory-machining criteria.
6. Factory- finishing specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:

1. Door schedule indicating door location, type, size, and swing.
2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
3. Details of frame for each frame type, including dimensions and profile.
4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
5. Dimensions and locations of blocking for hardware attachment.
6. Dimensions and locations of mortises and holes for hardware.
7. Clearances and undercuts.
8. Requirements for veneer matching.
9. Doors to be factory finished and application requirements.

10. Apply AWI Quality Certification Program label to Shop Drawings.

C. Samples for Initial Selection: For factory-finished doors.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.

1. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
2. Submit copy of DHI's Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Special warranties.

1.6 QUALITY ASSURANCE

A. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies complies with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.8 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install doors until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of construction period.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Delamination of veneer.
b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.

2. Warranty also includes installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid-Core Interior Doors: Five years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with AWI/AWMAC/WI's "Architectural Woodwork Standards."

1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.

2.2 SOLID-CORE FIVE-PLY FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Doors, Solid-Core Five-Ply Veneer-Faced:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Masonite Architectural.
b. Oregon Door.
c. Oshkosh Door Company.
d. VT Industries, Inc.

2. Performance Grade: ANSI/WDMA I.S. 1A Extra Heavy Duty.
3. Architectural Woodwork Standards Grade: Custom.
4. Faces: Single-plywood veneer not less than 1/50 inch thick.

a. Species (WD-1): Provide products specified on the Finish Schedule.
b. Cut: Rift cut.

c. Match between Veneer Leaves: Book match.
d. Assembly of Veneer Leaves on Door Faces: Center-balance match.
e. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
f. Room Match:

1) Provide door faces of compatible color and grain within each separate room or area of building.

5. Exposed Vertical Edges: Same species as faces - Architectural Woodwork Standards edge Type A.
6. Core for Non-Fire-Rated Doors:

a. ANSI A208.1, Grade LD-1 particleboard.

1) Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.

7. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.3 LIGHT FRAMES AND LOUVERS

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.

1. Wood Species: Same species as door faces.
2. Profile: Flush rectangular beads.

2.4 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated.

1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.

B. Factory machine doors for hardware that is not surface applied.

1. Locate hardware to comply with DHI-WDHS-3.
2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.

C. Openings: Factory cut and trim openings through doors.

1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

2.5 FACTORY FINISHING

A. Comply with referenced quality standard for factory finishing.

1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
2. Finish faces, all four edges, edges of cutouts, and mortises.

B. Factory finish doors.

C. Transparent Finish:

1. Architectural Woodwork Standards Grade: Custom.
2. Architectural Woodwork Standards System-9, UV Curable, Acrylated Epoxy, Polyester or Urethane.
3. Staining: Match Architect's sample.
4. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames, with Installer present, before hanging doors.

1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Section 087100 "Door Hardware."

B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:

1. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access doors and frames.
2. Fire-rated access doors and frames.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, fire ratings, material descriptions, dimensions of individual components and profiles and finishes.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing and inspecting agency.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

1.4 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

1.5 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies meets the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, according to NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Exposed Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ACUDOR Products, Inc.
    b. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
    c. Milcor; Hart & Cooley, Inc.
    d. Nystrom, Inc.
    e. Williams Bros. Corporation of America (The).

2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
3. Locations: Wall and ceiling.
4. Door Size: As required to access systems and as indicated on drawings, but not less than 12 inches by 12 inches in wall, or 24 inches by 24 inches in ceiling.
5. Stainless Steel Sheet for Door: Nominal 0.062 inch, 16 gage, ASTM A480/A480M No. 4 finish.
6. Frame Material: Same material, thickness, and finish as door.
7. Latch and Lock: Cam latch, screwdriver operated.

B. Recessed Access Doors with Concealed Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ACUDOR Products, Inc.
    b. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
    c. Milcor; Hart & Cooley, Inc.
    d. Nystrom, Inc.
    e. Williams Bros. Corporation of America (The).

2. Description: Door face recessed 5/8 inch for gypsum board infill; with concealed flange for gypsum board installation and concealed hinge.
3. Locations: Wall and ceiling.
4. Door Size: As required to access systems and as indicated on drawings, but not less than 12 inches by 12 inches in wall, or 24 inches by 24 inches in ceiling.
5. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage, factory primed.
6. Latch and Lock: Cam latch, screwdriver operated.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

A. Fire-Rated, Recessed Access Doors with Concealed Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ACUDOR Products, Inc.
    b. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
    c. Milcor; Hart & Cooley, Inc.
    d. Nystrom, Inc.
    e. Williams Bros. Corporation of America (The).

2. Description: Door face flush with frame, uninsulated; with concealed flange for gypsum board installation, self-closing door, and concealed hinge.
3. Locations: Wall and ceiling.
4. Door Size: As required to access systems and as indicated on drawings, but not less than 12 inches by 12 inches in wall, or 24 inches by 24 inches in ceiling.
5. Fire-Resistance Rating: Not less than that of adjacent construction.
6. Uncoated Steel Sheet for Door: Nominal 0.036 inch, 20 gage, factory primed.
7. Frame Material: Same material, thickness, and finish as door.
8. Latch and Lock: Self-closing, self-latching door hardware, operated by key.

2.4 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.

C. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, Type 304. Remove tool and die marks and stretch lines, or blend into finish.

D. Frame Anchors: Same material as door face.

E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.5 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.

2.6 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Stainless Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: ASTM A480/A480M No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.

a. Run grain of directional finishes with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated access door in accordance with NFPA 80, Section 5.2.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated access door indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

SECTION 083800 – TRAFFIC DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: [Note to Specifier: Need to confirm – this item only occurs in Phase 1 and Phase 2]

1. Interior traffic doors.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Interior traffic doors.

B. Product Data Submittals: For each product.

C. Shop Drawings: Include the following:

1. Elevations of each traffic door type.
2. Details of doors.
3. Details of each different wall opening condition.
4. Details of hardware and accessories.
5. Details of moldings and glazing.

D. Product Schedule: For traffic doors, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranties: For traffic doors.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver traffic doors packaged or crated to provide protection during transit and Project-site storage.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of traffic doors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TRAFFIC DOORS

A. Traffic Doors: 3/4 inch exterior grade solid wood core; 1 inch total thickness; light to medium duty.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Eliason Corporation; SCP-3, or approved equal.
2. Full Length Panels: 20 gauge stainless steel both sides; stainless steel top hinge covers.
3. Window Size: 9 inches wide by 14 inches high.
4. Window Molding: Black rubber molding.
5. Glazing: Clear acrylic.
6. Hinges: Manufacturer’s standard double action hinges.

a. Finish: Stainless Steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Verify jambs are plumb and square.

3.2 INSTALLATION

A. Install traffic doors plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Fit and adjust traffic doors accurately in opening.

3.3 PROTECTION

A. Protect installed products until completion of project.

B. Replace damaged products before Substantial Completion.

END OF SECTION 083800

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum-framed storefront systems.
2. Aluminum-framed entrance door systems.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:

a. Joinery, including concealed welds.
b. Anchorage.
c. Expansion provisions.
d. Glazing.
e. Flashing and drainage.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
4. Include point-to-point wiring diagrams showing the following:

a. Power requirements for each electrically operated door hardware.

b. Location and types of switches, signal device, conduit sizes, and number and size of wires.
c. Provide and indicate pathways for security wires related to access control where electrified door hardware is required.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication, and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates:

1. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.

a. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.

B. Test and Evaluation Reports:

1. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by qualified testing agency.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

D. Qualification Statements:

1. For Installer and field-testing agency.
2. For egress door inspector.

a. Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
b. Submit copy of DHI's Fire and Egress Door Assembly Inspector (FDAI) certificate.

E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For aluminum-framed entrances and storefronts.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Installers: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors.
2. Testing Agency: Qualified in accordance with ASTM E699 for testing indicated and acceptable to Owner and Architect.
3. Egress Door Inspector: Inspector for field quality-control inspections of egress door assemblies shall comply with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

    a. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.7 MOCKUPS

A. Build in-place mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical storefront location.
2. Testing shall be performed on mockups in accordance with requirements in "Field Quality Control" Article.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures, including, but not limited to, excessive deflection.

b. Noise or vibration created by wind and thermal and structural movements.
c. Deterioration of metals and other materials beyond normal weathering.
d. Water penetration through fixed glazing and framing areas.
e. Failure of operating components.

2. Warranty Period: Two years from date of First Day of Business (FDOB).

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

a. Thermal stresses transferring to building structure.
b. Glass breakage.
c. Noise or vibration created by wind and thermal and structural movements.
d. Loosening or weakening of fasteners, attachments, and other components.
e. Failure of operating units.

B. Structural Loads:

1. Wind Loads: As indicated on Drawings.

C. Deflection of Framing Members Supporting Glass: At design wind load, as follows:

1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches.
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.

D. Structural: Test in accordance with ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

E. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft.

F. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):

a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.35 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
b. Entrance Doors: U-factor of not more than 0.46 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.

2. Solar Heat-Gain Coefficient (SHGC):

a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.26 as determined in accordance with NFRC 200.
b. Entrance Doors: SHGC of not more than 0.26 as determined in accordance with NFRC 200.

3. Air Leakage:

a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft. when tested in accordance with ASTM E283.

b. Entrance Doors: Air leakage of not more than 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.

4. Condensation Resistance Factor (CRF):

a. Fixed Glazing and Framing Areas: CRF for the system of not less than 77 (frame) and 68 (glass) as determined in accordance with AAMA 1503.
b. Entrance Doors: CRF of not less than 49 (frame) and 68 (glass) as determined in accordance with AAMA 1503.

G. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.3 STOREFRONT SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer Trifab Versaglaze 451T Framing System, or approved equal.

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Exterior Framing Construction: Thermally broken.
2. Interior Vestibule Framing Construction: Nonthermal.
3. Glazing System: Retained mechanically with gaskets on four sides.
4. Glazing Plane: Front.
5. Finish: High-performance organic finish.
6. Fabrication Method: Field-fabricated stick system.
7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
8. Steel Reinforcement: As required by manufacturer.

C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.4 ENTRANCE DOOR SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer Insulpour Thermal Entrance (exterior) and Kawneer 500 Standard Entrance (interior), or approved equal.

B. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.

1. Door Construction, Exterior: 2- to 2-1/4-inch overall thickness, with minimum 0.125-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.

    a. Thermal Construction: Thermally broken.

2. Door Construction, Interior: 1-3/4 inch overall thickness, with minimum 0.125-inch-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
3. Door Design: Wide stile; 5-inch.

    a. Bottom Rail: 10-inch.

4. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.

    a. Provide nonremovable glazing stops on outside of door.

5. Finish: Match adjacent storefront framing finish.

2.5 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."

B. General: Provide entrance door hardware to comply with requirements in this Section.

1. Opening-Force Requirements:

    a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion and not more than 15 lbf to open the door to its minimum required width.
    b. Accessible Interior Doors: Not more than 5 lbf to fully open door.

C. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

D. Weather Stripping: Manufacturer's standard replaceable components.

1. Compression Type: Made of ASTM D2000 molded neoprene or ASTM D2287 molded PVC.
2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

E. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

F. Thresholds: BHMA A156.21 raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch.

1. Material: Heavy-duty extruded aluminum; clear anodized finish.

2.6 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

2.7 MATERIALS

A. Sheet and Plate: ASTM B209.

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.

C. Structural Profiles: ASTM B308/B308M.

D. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM and prepare surfaces in accordance with applicable SSPC standard.

2.8 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

B. Concealed Flashing: Dead-soft, 0.018-inch-thick stainless steel, complying with ASTM A240/A240M, of type recommended by manufacturer.

C. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.

2.9 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from interior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Storefront Framing: Fabricate components for assembly using shear-block system.

F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

1. At interior and exterior doors, provide compression weather stripping at fixed stops.

G. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
2. At exterior doors provide weather sweeps applied to door bottoms.

H. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

I. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.10 ALUMINUM FINISHES

A. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Seal perimeter and other joints watertight unless otherwise indicated.

G. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

I. Install joint filler behind sealant as recommended by sealant manufacturer.

J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

3.4 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE DOORS

A. Install entrance doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware in accordance with entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.5 ERECTION TOLERANCES

A. Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:

    a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
    b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
    c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections: Perform the following tests on mockups.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration.

    a. Perform a minimum of two tests in areas as directed by Architect.

2. Egress Door Inspections: Inspect each aluminum-framed entrance door equipped with panic hardware, each aluminum-framed entrance door located in an exit enclosure, each electrically controlled aluminum-framed egress door, and each aluminum-framed entrance door equipped with special locking arrangements, in accordance with NFPA 101, Section 7.2.1.15.

C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 084113

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.

C. Related Sections:

1. Division 08 Section “Hollow Metal Doors and Frames”.
2. Division 08 Section “Flush Wood Doors”.
3. Division 08 Section “Aluminum-Framed Entrances and Storefronts”

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
3. Content: Include the following information:

    a. Type, style, function, size, label, hand, and finish of each door hardware item.
    b. Manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    e. Explanation of abbreviations, symbols, and codes contained in schedule.
    f. Mounting locations for door hardware.
    g. Door and frame sizes and materials.
    h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at the earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

    a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
    b. Complete (risers, point-to-point) access control system block wiring diagrams.
    c. Wiring instructions for each electronic component scheduled herein.

1. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

E. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

F. Operating and Maintenance Manuals: Provide manufacturer’s operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum five (5) years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum five (5) years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

A. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.

B. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

C. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

D. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the system's operation.

C. Warranty Period: Unless otherwise indicated, warranty shall be one (1) year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BUTT HINGES

A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

a. Two Hinges: For doors with heights up to 60 inches.
b. Three Hinges: For doors with heights 61 to 90 inches.

a. Four Hinges: For doors with heights 91 to 120 inches.
b. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:

a. Hager Companies (HA) - BB Series, 5 knuckle.
b. Ives (IV) - 5BB Series, 5 knuckle.
c. McKinney (MK) - TB/T4B Series, 5 knuckle.
d. dormakaba Best (ST) - F/FBB Series, 5 knuckle.

2.2 CONTINUOUS HINGES

A. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 continuous geared hinge. with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

a. Hager Companies (HA).
b. Ives (IV).
c. Pemko (PE).

2.3 POWER TRANSFER DEVICES

A. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to

A. accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

a. Pemko (PE) - EL-CEPT Series.
b. Securitron (SU) - EL-CEPT Series.
c. Von Duprin (VD) - EPT-10 Series.

B. Provide mortar guard enclosure on steel frames installed at masonry openings for each electrical hinge specified.

2.4 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
5. Manufacturers:

a. Ives (IV).
b. Rockwood (RO).
c. Trimco (TC).

B. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
4. Manufacturers:

a. Ives (IV).
b. Rockwood (RO).
c. Trimco (TC).

2.5 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum ten (10) years experience designing secured master key systems and have on record a published security keying system policy.

1. Manufacturers:

a. Schlage (SC), Large Format Interchangeable Core (LFIC).
b. No Substitution, except where approved by the Owner.

B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
6. Keyway: Match Facility Restricted Keyway.

C. Security Cylinders: ANSI/BHMA A156.5, Grade 1 Certified Products Directory (CPD) listed security cylinders and keys able to be used together under the same facility master or grandmaster key system.

1. New security key systems shall not be established with products that have an expired patent. Expired systems shall only be specified and supplied to support existing systems.
2. Manufacturers:

a. Schlage (SC) - Primus Everest, Large Format Interchangeable Core (LFIC).
b. No Substitution, except where approved by the Owner.

D. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. New System: Key locks to a new key system as directed by the Owner. Coordinate with the keying system for the entire campus.

E. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).

F. Construction Keying: Provide construction master keyed cylinders.

G. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
1. Provide transcript list in writing or electronic file as directed by the Owner.

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Where specified, provide status indicators with highly reflective color and wording for “locked/unlocked” or “vacant/occupied” with custom wording options if required. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status. Indicator window size to be a minimum of 2.1” x 0.6” with a curved design allowing a 180-degree viewing angle with protective covering to prevent tampering.
2. Manufacturers:

    a. Corbin Russwin Hardware (RU) - ML2000 Series.
    b. dormakaba Best (BE) - 45H Series.
    c. Schlage (SC) - L9000 Series.

B. Cylindrical Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.2, Series 4000, Operational Grade 1 Certified Products Directory (CPD) listed.

1. Vertical Impact: Exceed 100 vertical impacts (20 times ANSI/BHMA A156.2 requirements).
2. Furnish with solid cast levers, standard 2 3/4” backset, and 1/2" (3/4" at rated paired openings) throw brass or stainless steel latchbolt.
3. Locks are to be non-handed and fully field reversible.
4. Manufacturers:

    a. Corbin Russwin Hardware (RU) - CLX3300 Series.
    b. dormakaba Best (BE) - 9K Series.
    c. Schlage (SC) - ND Series.

2.7 ELECTROMECHANICAL LOCKING DEVICES

A. Electromechanical Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed, subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below and in the hardware sets.

1. Electrified Lock Options: Where indicated in the Hardware Sets, provide electrified options including: outside door lock/unlock trim control, latch bolt and lock/unlock status monitoring, deadbolt monitoring, and request-to-exit signaling. Support end-of-line

1. resistors contained within the lock case. Unless otherwise indicated, provide electrified locksets standard as fail secure.
2. Manufacturers:

    a. Corbin Russwin Hardware (RU) - ML20900 ECL-SEC Series.
    b. dormakaba Best (BE) - 45HW EL/EU Series.
    c. Schlage (SC) - L9000 EL/EU/RX Series.
    d. No Substitution.

2.8 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latch bolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.9 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.
3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the push bar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.

1. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

    a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

2. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
3. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.
4. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
5. Rail Sizing: Provide exit device rails factory sized for proper door width application.
6. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

1. Manufacturers:

    a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
    b. dormakaba Best (PR) - Apex 2000 Series.
    c. Von Duprin (VD) - 33A/99 Series.

2.10 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

A. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Manufacturers:

a. Corbin Russwin Hardware (RU) - DC8000 Series.
b. LCN Closers (LC) - 4040XP Series.
c. Norton Rixson (NO) - 9500 Series.

2.11 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:

a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:

a. Ives (IV).
b. Rockwood (RO).
c. Trimco (TC).

2.12 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will

A. impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

a. Ives (IV).
b. Rockwood (RO).
c. Trimco (TC).

B. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:

a. Norton Rixson (RF).
b. Rockwood (RO).
c. Glynn Johnson (GJ).

2.13 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

1. National Guard Products (NG).
1. Pemko (PE).
2. Reese Enterprises, Inc. (RE).
3. Zero (ZE).

2.14 ELECTRONIC ACCESSORIES

A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap- lock into a 1" diameter hole. Surface mounted models include a wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Manufacturers:

a. Magnasphere (OT) – MSS-310C-GO Series –Supplied by Security Contractor.
b. Door and Frame Supplier to prep for this Door Position Switch
c. No Substitution.

2.15 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.16 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection (Punch Report): Reference Division 01 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include a list of items to be

completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.

1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.

A. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. OT - Other
4. RO - Rockwood
5. VD - Von Duprin
6. SC - Schlage
7. GJ - Glynn-Johnson
8. LC - LCN Closers

B.

SET NO. 1.0

DOORS:

110 228

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	PUSH PLATE	8200 10" X 16"		630	IVE
1	EA	PULL PLATE	8302 10" 10" X 16"		630	IVE
1	EA	HANDS FREE FOOT PULL	FP100		630	IVE
1	EA	DOOR CLOSER (REG ARM/PULL SIDE)	4040XP REG		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE

SET NO. 2.0

DOORS:

111.1	111.2	111.3	111.4	111.5	111.7
205	206	228.1	228.2	228.3	228.4
228.5	228.7				

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	MORTISE LOCK (OFFICE/PRIVACY W/INDICATOR)	L9056T 06B L583-363 OS-OCC		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE

SET NO. 2.1

DOORS:

111.9		228.9				

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	MORTISE LOCK (OFFICE/PRIVACY W/INDICATOR)	L9056T 06B L583-363 OS-OCC		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
1	EA	OVERHEAD STOP (SURFACE)	900S SERIES		630	GLY
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE

SET NO. 3.0

DOORS:

111.6		228.6				

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	SPRING HINGE	1502 4-1/2" X 4-1/2"		US26D	MCK
1	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	MORTISE LOCK (OFFICE/PRIVACY W/INDICATOR)	L9056T 06B L583-363 OS-OCC		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE

SET NO. 4.0

DOORS:

104	114	115	116	117	118
119	122	123	124	125	215
216	220	221	222	223	225
302	303	304	305	307	309
311	315	316	317	318	319

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	PASSAGE SET	ND10S RHO		626	SCH
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA	GASKETING	488SBK (HEAD AND JAMBS)		BK	ZER
1	EA	DOOR BOTTOM	360AA		AA	ZER

SET NO. 5.0

DOORS:
107B 202A 202B 202C

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
	EA		ALL HARDWARE BY DOOR AND FRAME SUPPLIER			

SET NO. 6.0

DOORS:
127 207 211

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	ENTRANCE LOCK	ND53TD RHO		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA	GASKETING	488SBK (HEAD AND JAMBS)		BK	ZER
1	EA	DOOR BOTTOM	360AA		AA	ZER

SET NO. 7.0

DOORS:
217

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	CLASSROOM LOCK	ND70TD RHO		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
1	EA	DOOR CLOSER (REG ARM/PULL SIDE)	4040XP REG		689	LCN
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE

SET NO. 8.0

DOORS:
208A 208B

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	PANIC HARDWARE	98-L-BE-06		US26D	VON
1	EA	DOOR CLOSER (HVY DUTY ARM, PUSH SIDE)	4040XP EDA		689	LCN
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA	GASKETING	488SBK (HEAD AND JAMBS)		BK	ZER
1	EA	AUTOMATIC DOOR BOTTOM	355AA		AA	ZER

SET NO. 8.1 (DOUBLE DOOR WITH HOLD OPEN)

DOORS:
208A (REV4.1 ONLY)

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
2	EA	PANIC HARDWARE	9847-L-BE-LBR-06		626	VON
2	EA	SURFACE CLOSER	4040XP HEDA		689	LCN
2	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE
2	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA	GASKETING	488SBK (HEAD AND JAMBS)		BK	ZER
2	EA	AUTOMATIC DOOR BOTTOM	355AA		AA	ZER

SET NO. 9.0

DOORS:
112 121

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	PATCH FITTING W/FLOOR CLOSER	PATCH FITTING W/FLOOR CLOSER BY DOOR AND FRAME SUPPLIER		US26D	B/O
1	EA	DOOR PULL SET (2 EA, BTB MTD)	RM3301-48" X MP X MTG TYPE 14XHD		US32D	ROC
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA		WEATHERSTRIP BY DOOR/FRAME MANUFACTURER			

SET NO. 10.0

DOORS:
107A

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
2	EA	MANUAL FLUSH BOLT	FB458		BLK	IVE
1	EA	DUST PROOF STRIKE	DP2		626	IVE
1	EA	CLASSROOM LOCK	ND70TD RHO		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
1	EA	DOOR CLOSER (REG ARM/PULL SIDE)	4040XP REG		689	LCN
2	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE
2	EA	DOOR STOP & HOLDER	494R		US26D	ROC
1	EA	ASTRAGAL	47A-SEC		A	ZER

SET NO. 11.0

DOORS:
E101

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112XY		628	IVE
2	EA	FIRE EXIT HARDWARE	9847-L-BE-F-06		626	VON
2	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
2	EA	PA MOUNTING PLATE	4040XP-18PA		693	LCN
2	EA	CUSH SHOE SUPPORT	4040XP-30		689	LCN
2	EA	BLADE STOP SPACER	4040XP-61		689	LCN
1	EA	THRESHOLD	655A		A	ZER
2	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR			
1	EA		WEATHERSTRIP BY DOOR/FRAME MANUFACTURER			

THIS HARDWARE SET APPLIES TO THE FOLLOWING:
DOOR **E101** IN POR3.0-REV4.0 PHASE 1 AREA A, WHEN AREA B WILL BE INCLUDED IN A LATER PHASE.

DOOR TO BE INSTALLED IN PHASE 1, AND WALLED OVER UNTIL AREA B IS BUILT.

WHERE **AREA A ONLY** WILL BE BUILT OUT, DOOR **E101** USES **HW SET 25.0**.

SET NO. 11.1

DOORS:
E108A E108B

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	WELDED ON PIVOTS/HINGES	PROVIDED BY FIRE RATED GLASS DOOR MANUF		US26D	
2	EA	FIRE EXIT HARDWARE	3547A-L-BE-F-06		626	VON
2	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	FIRE RATED SEALS	PROVIDED BY FIRE RATED GLASS DOOR MANUF			
1	EA	THRESHOLD	655A		A	ZER
2	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR			

THIS HARDWARE SET APPLIES TO THE FOLLOWING:
DOOR **E108A** IN POR3.0-REV4.0 PHASE 1 AREA A, WHEN AREA B WILL BE INCLUDED IN A LATER PHASE.

DOORS **E108A** AND **E108B** IN POR3.0-REV4.1 AREA A, WHEN AREA B WILL BE INCLUDED IN A LATER PHASE.

DOOR TO BE INSTALLED IN PHASE 1, AND WALLED OVER UNTIL AREA B IS BUILT.

WHERE **AREA A ONLY** WILL BE BUILT OUT, DOOR(S) **E108A** AND **E108B (4.1 ONLY)** WILL USE **HW SET 19.0.**

SET NO. 12.0

DOORS:

106	111.8	218	226	228.8	306
313	314				

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE

SET NO. 12.1

DOORS:
109

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
1	EA	OVERHEAD STOP (SURFACE)	900S SERIES		630	GLY
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE

SET NO. 13.0

DOORS:
107C

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
1	EA	OVERHEAD STOP (SURFACE)	900S SERIES		630	GLY
1	EA	DOOR CLOSER (REG ARM/PULL SIDE)	4040XP REG		689	LCN
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE

A CONFLICT MAY OCCUR BETWEEN THE OH STOP THRU-BOLT AND THE CLOSER CYLINDER BODY. IF THIS CONFLICT OCCURS, A 4040XP-18 DROP PLATE WILL HAVE TO BE USED AND THE PLATE DRILLED OUT TO PROVIDE CLEARANCE FOR THE THRU-BOLT HEAD.

SET NO. 14.0

DOORS:
204

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK (HEAD AND JAMBS)		BK	ZER

SET NO. 15.0

DOORS:
224 312

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO		626	SCH
1	EA	RIM CYLINDER	20-057 ICX (INC. CONST. CORE)		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
1	EA	DOOR CLOSER (HVY DUTY ARM, PUSH SIDE)	4040XP EDA		689	LCN
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA	GASKETING	488SBK (HEAD AND JAMBS)		BK	ZER

SET NO. 16.0

DOORS:
209

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
2	EA	MANUAL FLUSH BOLT	FB458		BLK	IVE
1	EA	DUST PROOF STRIKE	DP2		626	IVE
1	EA	STOREROOM LOCK	ND80TD RHO		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
2	EA	OVERHEAD STOP (SURFACE)	900S SERIES		630	GLY
2	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE
1	EA	ASTRAGAL	ASTRAGAL BY DOOR MANUFACTURER			

SET NO. 17.0

DOORS:
E201A E310A

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	112XY		628	IVE
1	EA	PANIC HARDWARE	98-EO		626	VON
1	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA		693	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30		689	LCN
1	EA	BLADE STOP SPACER	4040XP-61		689	LCN
1	EA	RAIN DRIP	142AA-SEC (DOOR WIDTH + 10”)		AA	ZER
1	EA	DOOR SWEEP	339AA-SEC		AA	ZER
1	EA	THRESHOLD	655A		A	ZER
1	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR			
1	EA		WEATHERSTRIP BY DOOR/FRAME MANUFACTURER			

PHASE 1:

SECURITY DEVICES TO BE ROUGHED IN ONLY IN PHASE 1 WHEN AREA B AND/OR AREAS B AND C WILL BE BUILT IN PHASE 2 AND/OR PHASE 3.

PHASE 2 AND/OR PHASE 3:
DOOR POSITION SWITCH TO BE INSTALLED FOR CLIENT TURNOVER.

OPERATION:
DOOR POSITION SWITCH MONITORS DOOR STATUS. OPENING DOOR FROM EGRESS SIDE WILL ACTIVATE AN ALARM.

SET NO. 18.0

DOORS:
E112

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112XY		628	IVE
2	EA	PANIC HARDWARE	LD-9847-EO		626	VON
2	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	RAIN DRIP	142AA-SEC (DOOR WIDTH + 4")		AA	ZER
1	EA	GASKETING	328AA (@ HEAD AND JAMBS)		AA	ZER
2	EA	MEETING STILE	328AA		AA	ZER
2	EA	DOOR SWEEP	39A-SEC		A	ZER
1	EA	THRESHOLD	655A		A	ZER
1	EA	CLOSER MTG BKT	328SPB @ HEAD FOR CLOSER MOUNTING			ZER
2	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR			

OPERATION:
EMERGENCY EXIT ONLY DOOR. DOOR POSITION SWITCH MONITORS DOOR STATUS. OPENING DOOR FROM EGRESS SIDE WILL ACTIVATE AN ALARM.

SET NO. 18.1

DOORS:
E210

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112XY		628	IVE
2	EA	PANIC HARDWARE	LD-9847-EO		626	VON
2	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
2	EA	PA MOUNTING PLATE	4040XP-18PA		693	LCN
2	EA	CUSH SHOE SUPPORT	4040XP-30		689	LCN
2	EA	BLADE STOP SPACER	4040XP-61		689	LCN
1	EA	RAIN DRIP	142AA-SEC (DOOR WIDTH + 10”)		AA	ZER
1	EA	THRESHOLD	655A		A	ZER
2	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR			
1	EA		WEATHERSTRIP BY DOOR/FRAME MANUFACTURER			

(STOREFRONT OPENING)

OPERATION:
EMERGENCY EXIT ONLY DOOR. DOOR POSITION SWITCH MONITORS DOOR STATUS. OPENING DOOR FROM EGRESS SIDE WILL ACTIVATE AN ALARM.

SET NO. 19.0

DOORS:
E108A (AREA A ONLY)
E108B (AREA A ONLY, REV4.1)

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	WELDED ON PIVOTS/HINGES	PROVIDED BY FIRE RATED GLASS DOOR MANUF		US26D	
2	EA	FIRE EXIT HARDWARE	3547A-L-F-06		626	VON
2	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	RAIN DRIP	142AA-SEC (DOOR WIDTH + 4")		AA	ZER
1	EA	FIRE RATED SEALS	PROVIDED BY FIRE RATED GLASS DOOR MANUF			
1	EA	THRESHOLD	655A		A	ZER
2	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR			

DOOR E108A **AND IN** REV4.1 E108A **AND** E108B **USE THIS HW SET WHEN** PHASE 1/AREA A ONLY **WILL BE BUILT FOR THE CLIENT, AND DOOR POSITION SWITCHES WILL BE ROUGHED IN AND INSTALLED IN PHASE 1.**

OPERATION:
DOOR POSITION SWITCH MONITORS DOOR STATUS. OPENING DOOR FROM EGRESS SIDE WILL ACTIVATE AN ALARM.

IF AREA B IS BUILT OUT (IN THE FUTURE), DECOMMISSION SECURITY DEVICES, AND LEAVE LEVER TRIM UNLOCKED FOR FREE PASSAGE IN BOTH DIRECTIONS.

SET NO. 20.0

DOORS:
105

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
2	EA	HINGE	5BB1HW 4.5 X 4.5			652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 CON TW8			652	IVE
1	EA	EU MORTISE LOCK	L9492TEU 06B L583-363 RX DM CON 12/24 VDC			626	SCH
1	EA	INDICATOR (FOR MORTISE LOCKSET)	PART# 47804352 (OS-OCC INDICATOR KIT)			US26D	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING			US26D	SCH
1	EA	DOOR CLOSER (REG ARM/PULL SIDE)	4040XP REG			689	LCN
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS			630	IVE
1	EA	WALL STOP	WS406/407CCV			630	IVE
1	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR				
1	EA		POWER SUPPLY BY SECURITY CONTRACTOR				
	EA		CARD READER PROVIDED BY SECURITY CONTRACTOR				

*INDICATOR SHALL BE INSTALLED AT THE SAME TIME AS THE EU MORTISE LOCKSET, AND SHALL PROVIDE OCCUPIED/VACANT INDICATION FROM THE OUTSIDE OF THE DOOR.

OPERATION:

DOOR IS NORMALLY CLOSED AND LOCKED
OUTSIDE CARD READER WILL UNLOCK DOOR FOR ENTRY.
ONCE OCCUPANT TURNS THE INSIDE THUMBTURN TO THROW THE DEADBOLT, THE DM SWITCH (INTERNAL TO THE LOCK) CAN SIGNAL THE ACCESS CONTROL SYSTEM TO NOT ALLOW CARDS TO ACCESS THE ROOM WHILE IN USE.
TURNING INSIDE LEVER WILL RETRACT PRIVACY DEADBOLT AND LATCHBOLT IN ONE MOTION.
FREE EGRESS ALWAYS PERMITTED
COORDINATE WITH SECURITY CONTRACTOR.

SET NO. 21.0

DOORS:
103 214 308

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 CON TW8		652	IVE
1	EA	EU MORTISE LOCK	L9092TEU 06B RX CON 12/24 VDC		626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING		US26D	SCH
1	EA	DOOR CLOSER (REG ARM/PULL SIDE)	4040XP REG		689	LCN
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR			
1	EA		POWER SUPPLY BY SECURITY CONTRACTOR			
	EA		CARD READER PROVIDED BY SECURITY CONTRACTOR			

OPERATION:

DOOR IS NORMALLY CLOSED AND LOCKED.
OUTSIDE CARD READER WILL UNLOCK DOOR FOR ENTRY.
FREE EGRESS ALWAYS PERMITTED.
INSIDE LEVER/TOUCHBAR HAS RX (REQUEST TO EXIT) SWITCH TO SIGNAL AUTHORIZED EGRESS.
COORDINATE WITH SECURITY CONTRACTOR.

SET NO. 22.0

DOORS:
113

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
2	EA	HINGE	5BB1HW 4.5 X 4.5			652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 CON TW8			652	IVE
1	EA	EU MORTISE LOCK	L9092TEU 06B CON 12/24 VDC			626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING			US26D	SCH
1	EA	DOOR CLOSER (REG ARM/PULL SIDE)	4040XP REG			689	LCN
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS			630	IVE
1	EA	WALL STOP	WS406/407CCV			630	IVE
1	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR				
1	EA		POWER SUPPLY BY SECURITY CONTRACTOR				
	EA		CARD READER PROVIDED BY SECURITY CONTRACTOR				

OPERATION:
DOOR IS NORMALLY CLOSED AND LOCKED.
OUTSIDE CARD READER W/KEYPAD WILL UNLOCK DOOR FOR ENTRY.
INSIDE CARD READER WILL BYPASS ALARM FOR EGRESS.
EXITING THE ROOM WITHOUT PRESENTING YOUR CARD WILL SOUND AN ALARM.
COORDINATE WITH SECURITY CONTRACTOR.

SET NO. 23.0

DOORS:
209.2

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
2	EA	HINGE	5BB1HW 4.5 X 4.5			652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 CON TW8			652	IVE
1	EA	EU MORTISE LOCK	L9092TEU 06B RX CON 12/24 VDC			626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING			US26D	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH			689	LCN
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS			630	IVE
1	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR				
1	EA		POWER SUPPLY BY SECURITY CONTRACTOR				
	EA		CARD READER PROVIDED BY SECURITY CONTRACTOR				

PHASE 1:

MORTISE LOCKSET TO BE INSTALLED IN ‘FAIL SECURE’ MODE.
SECURITY DEVICES TO BE ROUGHED IN ONLY.

OPERATION PHASE 1:
LOCKSET WILL BE ‘STOREROOM FUNCTION’ IN ITS UNPOWERED STATE.

PHASE 2 AND/OR PHASE 3:
SECURITY DEVICES TO BE INSTALLED FOR CLIENT TURNOVER. POWER TO BE CONNECTED TO THE DOOR HARDWARE FOR OPERATION BELOW:

OPERATION:
DOOR IS NORMALLY CLOSED AND LOCKED.
OUTSIDE CARD READER WILL UNLOCK DOOR FOR ENTRY.
FREE EGRESS ALWAYS PERMITTED.
INSIDE LEVER/TOUCHBAR HAS RX (REQUEST TO EXIT) SWITCH TO SIGNAL AUTHORIZED EGRESS.
COORDINATE WITH SECURITY CONTRACTOR.

SET NO. 24.0

DOORS:
E203

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
2	EA	CONT. HINGE	112XY EPT			628	IVE
2	EA	POWER TRANSFER	EPT10 CON			689	VON
1	EA	ELEC PANIC HARDWARE	LD-RX-9847-EO-CON			626	VON
1	EA	ELEC PANIC HARDWARE	LD-RX-9847-L-M996-06-FSE-CON			626	VON
1	EA	RIM CYLINDER	20-057 ICX (INC. CONST. CORE)			626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING			US26D	SCH
2	EA	SURFACE CLOSER	4040XP SCUSH			689	LCN
2	EA	KICK PLATE	8400 32" X 1" LDW B-CS			630	IVE
1	EA	RAIN DRIP	142AA-SEC (DOOR WIDTH + 10”)			AA	ZER
1	EA	GASKETING	328AA (@ HEAD AND JAMBS) (@ JAMB LEGS ONLY)			AA	ZER
2	EA	MEETING STILE	328AA			AA	ZER
2	EA	DOOR SWEEP	339AA-SEC			AA	ZER
1	EA	HD THRESHOLD	1717A			AL	PEM
1	EA	CLOSER MTG BKT	328SPB @ HEAD FOR CLOSER MOUNTING				ZER
2	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR				
1	EA		POWER SUPPLY BY SECURITY CONTRACTOR				
	EA		CARD READER PROVIDED BY SECURITY CONTRACTOR				

PHASE 1:

EXIT DEVICE M996L ELECTRIFIED TRIM TO BE INSTALLED IN ‘FAIL SECURE’ MODE.
SECURITY DEVICES TO BE ROUGHED IN ONLY.
OUTSIDE LEVER WILL BE ‘STOREROOM FUNCTION’ IN ITS UNPOWERED STATE.

PHASE 2 AND/OR PHASE 3:

SECURITY DEVICES TO BE INSTALLED FOR CLIENT TURNOVER. POWER TO BE CONNECTED TO THE DOOR HARDWARE FOR OPERATION BELOW:

OPERATION:

DOOR IS NORMALLY CLOSED AND LOCKED.
OUTSIDE CARD READER WILL UNLOCK DOOR FOR ENTRY.
FREE EGRESS ALWAYS PERMITTED.
INSIDE LEVER/TOUCHBAR HAS RX (REQUEST TO EXIT) SWITCH TO SIGNAL AUTHORIZED EGRESS.
COORDINATE WITH SECURITY CONTRACTOR.

SET NO. 25.0

DOORS:
E101 (AREA A ONLY)

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
2	EA	CONT. HINGE	112XY EPT			628	IVE
2	EA	POWER TRANSFER	EPT10 CON			689	VON
1	EA	ELEC PANIC HARDWARE	LD-RX-9847-EO-CON			626	VON
1	EA	ELEC PANIC HARDWARE	LD-RX-9847-L-M996-06-FSE-CON			626	VON
1	EA	RIM CYLINDER	20-057 ICX (INC. CONST. CORE)			626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING			US26D	SCH
2	EA	SURFACE CLOSER	4040XP SCUSH			689	LCN
2	EA	PA MOUNTING PLATE	4040XP-18PA			693	LCN
2	EA	CUSH SHOE SUPPORT	4040XP-30			689	LCN
2	EA	BLADE STOP SPACER	4040XP-61			689	LCN
1	EA	RAIN DRIP	142AA-SEC (DOOR WIDTH + 4")			AA	ZER
1	EA	DOOR SWEEP	339AA-SEC			AA	ZER
1	EA	THRESHOLD	655A			A	ZER
2	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR				
1	EA		POWER SUPPLY BY SECURITY CONTRACTOR				
	EA		CARD READER PROVIDED BY SECURITY CONTRACTOR				
1	EA		WEATHERSTRIP BY DOOR/FRAME MANUFACTURER				

DOOR E101**, WHEN** AREA A ONLY **WILL BE BUILT OUT. DOOR SWING WILL BE REVERSED TO SWING 'OUT'.**

OPERATION:
DOOR IS NORMALLY CLOSED AND LOCKED.
OUTSIDE CARD READER WILL UNLOCK DOOR FOR ENTRY.
FREE EGRESS ALWAYS PERMITTED.
INSIDE LEVER/TOUCHBAR HAS RX (REQUEST TO EXIT) SWITCH TO SIGNAL AUTHORIZED EGRESS.
COORDINATE WITH SECURITY CONTRACTOR.

SET NO. 26.0

DOORS:
E128 E129

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
1	EA	CONT. HINGE	112XY EPT			628	IVE
1	EA	POWER TRANSFER	EPT10 CON		✓	689	VON
1	EA	ELEC PANIC HARDWARE	LD-RX-98-L-M996-06-FSE-CON		✓	626	VON
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING			US26D	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH			689	LCN
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS			630	IVE
1	EA	RAIN DRIP	142AA-SEC (DOOR WIDTH + 10”)			AA	ZER
1	EA	GASKETING	328AA (@ HEAD AND JAMBS) (@ JAMB LEGS ONLY)			AA	ZER
1	EA	MEETING STILE	339AA SEC			AA	ZER
1	EA	THRESHOLD W/THERMAL BREAK	8724A-223			A	ZER
1	EA	CLOSER MTG BKT	328SPB @ HEAD FOR CLOSER MOUNTING				ZER
1	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR		✓		
1	EA		POWER SUPPLY BY SECURITY CONTRACTOR		✓		
	EA		CARD READER PROVIDED BY SECURITY CONTRACTOR		✓		

OPERATION:
DOOR IS NORMALLY CLOSED AND LOCKED.
OUTSIDE CARD READER WILL UNLOCK DOOR FOR ENTRY.
FREE EGRESS ALWAYS PERMITTED.
INSIDE LEVER/TOUCHBAR HAS RX (REQUEST TO EXIT) SWITCH TO SIGNAL AUTHORIZED EGRESS.
COORDINATE WITH SECURITY CONTRACTOR.

SET NO. 27.0

DOORS:
E201B

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
1	EA	CONT. HINGE	112XY EPT			628	IVE
1	EA	POWER TRANSFER	EPT10 CON			689	VON
1	EA	ELEC PANIC HARDWARE	LD-RX-98-L-M996-06-FSE-CON			626	VON
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING			US26D	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH			689	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA			693	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30			689	LCN
1	EA	BLADE STOP SPACER	4040XP-61			689	LCN
1	EA	KICK PLATE	8400 10” X 2" LDW B-CS			630	IVE
1	EA	RAIN DRIP	142AA-SEC (DOOR WIDTH + 10”)			AA	ZER
1	EA	THRESHOLD	655A			A	ZER
1	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR				
1	EA		POWER SUPPLY BY SECURITY CONTRACTOR				
	EA		CARD READER PROVIDED BY SECURITY CONTRACTOR				
1	EA		WEATHERSTRIP BY DOOR/FRAME MANUFACTURER				

PHASE 1:

EXIT DEVICE M996L ELECTRIFIED TRIM TO BE INSTALLED IN ‘FAIL SECURE’ MODE.
SECURITY DEVICES TO BE ROUGHED IN ONLY.
OUTSIDE LEVER WILL BE ‘STOREROOM FUNCTION’ IN ITS UNPOWERED STATE.

PHASE 2 AND/OR PHASE 3:

SECURITY DEVICES TO BE INSTALLED FOR CLIENT TURNOVER. POWER TO BE CONNECTED TO THE DOOR HARDWARE FOR OPERATION BELOW:

OPERATION:
DOOR IS NORMALLY CLOSED AND LOCKED.
OUTSIDE CARD READER WILL UNLOCK DOOR FOR ENTRY.
FREE EGRESS ALWAYS PERMITTED.
INSIDE LEVER/TOUCHBAR HAS RX (REQUEST TO EXIT) SWITCH TO SIGNAL AUTHORIZED EGRESS.
COORDINATE WITH SECURITY CONTRACTOR.

SET NO. 28.0

DOORS:
V102A

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
2	EA	CONT. HINGE	112XY EPT			628	IVE
2	EA	POWER TRANSFER	EPT10 CON			689	VON
1	EA	ELEC PANIC HARDWARE	LD-RX-9847-EO-CON			626	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-9847-L-M996-06-FSE-CON 24 VDC			626	VON
1	EA	RIM CYLINDER	20-057 ICX (INC. CONST. CORE)			626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING			US26D	SCH
1	EA	OH STOP	100S (@ AUTOMATIC DOOR)			630	GLY
1	EA	SURFACE CLOSER	4040XP SCUSH			689	LCN
1	EA	SURF. AUTO OPERATOR	4642 ST2776			689	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA			693	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30			689	LCN
1	EA	BLADE STOP SPACER	4040XP-61			689	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-810S			630	LCN
1	EA	RAIN DRIP	142AA-SEC (DOOR WIDTH + 10”)			AA	ZER
1	EA	DOOR SWEEP	339AA-SEC			AA	ZER
1	EA	THRESHOLD	655A			A	ZER
2	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR				
1	EA		POWER SUPPLY BY SECURITY CONTRACTOR				
	EA		CARD READER PROVIDED BY SECURITY CONTRACTOR				
	EA		MOTION SENSOR BY SECURITY CONTRACTOR				
1	EA		WEATHERSTRIP BY DOOR/FRAME MANUFACTURER				

OPERATION:
DOOR IS NORMALLY CLOSED AND LOCKED.
OUTSIDE CARD READER WILL UNLOCK DOOR FOR ENTRY.
FREE EGRESS ALWAYS PERMITTED.
INSIDE LEVER/TOUCHBAR HAS RX (REQUEST TO EXIT) SWITCH TO SIGNAL AUTHORIZED EGRESS.
COORDINATE WITH SECURITY CONTRACTOR.

SET NO. 29.0

DOORS:
V102B

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
2	EA	CONT. HINGE	112XY EPT			628	IVE
2	EA	POWER TRANSFER	EPT10 CON			689	VON
1	EA	ELEC PANIC HARDWARE	LD-RX-9847-EO-CON			626	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-9847-L-M996-06-FSE-CON 24 VDC			626	VON
1	EA	RIM CYLINDER	20-057 ICX (INC. CONST. CORE)			626	SCH
1	EA	KEYED CORE	LFIC, SEE 2.5 CYLINDERS AND KEYING			US26D	SCH
1	EA	OH STOP	100S (@ AUTOMATIC DOOR)			630	GLY
1	EA	SURFACE CLOSER	4040XP SCUSH			689	LCN
1	EA	SURF. AUTO OPERATOR	4642 ST2776			689	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA			693	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30			689	LCN
1	EA	BLADE STOP SPACER	4040XP-61			689	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-810S			630	LCN
2	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR				
1	EA		POWER SUPPLY BY SECURITY CONTRACTOR				
	EA		CARD READER PROVIDED BY SECURITY CONTRACTOR				
	EA		MOTION SENSOR BY SECURITY CONTRACTOR				

OPERATION:
DOOR IS NORMALLY CLOSED AND LOCKED.
OUTSIDE CARD READER WILL UNLOCK DOOR FOR ENTRY.
FREE EGRESS ALWAYS PERMITTED.
INSIDE LEVER/TOUCHBAR HAS RX (REQUEST TO EXIT) SWITCH TO SIGNAL AUTHORIZED EGRESS.
COORDINATE WITH SECURITY CONTRACTOR.

SET NO. 30.0

DOORS:
E211

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	BY GATE MFG			
1	EA	PANIC HARDWARE	LD-OUT-98-L-BE-06-WH		626	VON
1	EA	GATE CLOSER	1351 (REQUIRES SQUARE POST)			RIX

HARDWARE SET IS A GUIDELINE FOR INTENDED FUNCTION. GENERAL CONTRACTOR IS TO CONDUCT A COORDINATION MEETING WITH GATE FABRICATOR AND HARDWARE SUPPLIER PRIOR TO GATE BEING FABRICATED OR HARDWARE BEING ORDERED

SPECIFIED CLOSER REQUIRES A SQUARE POST TO MOUNT. IF THERE IS NOT A SQUARE POST, PROVIDE SELF-CLOSING GATE HINGES.

SET NO. 31.0

DOORS:
E310B

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	112XY		628	IVE
1	EA	PANIC HARDWARE	98-EO		626	VON
1	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	RAIN DRIP	142AA-SEC (DOOR WIDTH + 10”)		AA	ZER
1	EA	DOOR SWEEP	339AA-SEC		AA	ZER
1	EA	THRESHOLD	655A		A	ZER
1	EA		DOOR POSITION SWITCH BY SECURITY CONTRACTOR			
1	EA		WEATHERSTRIP BY DOOR/FRAME MANUFACTURER			

PHASE 1:
SECURITY DEVICES TO BE ROUGHED IN ONLY IN PHASE 1.

PHASE 3:
DOOR POSITION SWITCH TO BE INSTALLED FOR CLIENT TURNOVER.

OPERATION:
DOOR POSITION SWITCH MONITORS DOOR STATUS. OPENING DOOR FROM EITHER DIRECTION WILL ACTIVATE AN ALARM.

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass products.
2. Insulating glass.
3. Glazing tapes.
4. Miscellaneous glazing materials.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Experiential Graphics and Signage Bid Package for applied glazing film.

1.2 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.3 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.

C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturers of fabricated glass units.

B. Product Certificates: For glass.

C. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

A. Fabricated-Glass Manufacturer Qualifications: A qualified manufacturer of fabricated glass units who is approved by primary glass manufacturer.

B. Mockups: Build in-place mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Install glazing in mockups specified in Section 084113 "Aluminum-Framed Entrances and Storefronts" to match glazing systems required for Project, including glazing methods.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.10 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of First Day of Business (FDOB).

B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Glass: Obtain glass from single source from single manufacturer.

B. Source Limitations for Glazing Accessories: For each product and installation method, obtain from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:

1. Design Wind Pressures: As indicated on Drawings.

a. Wind Design Data: As indicated on Drawings.

2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.

C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic glass lites, properties are based on units with lites 6 mm thick.
2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
3. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F.
4. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. NGA Publications: "Glazing Manual."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.

1. Minimum Glass Thickness for Exterior Lites: 6 mm.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.

B. Low-Iron Annealed Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Guardian Glass LLC.
    b. Pilkington North America; NSG Group.
    c. Saint-Gobain Glass Corp.
    d. Vitro Architectural Glass.

C. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

D. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.

E. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.

2.5 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.

1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
2. Perimeter Spacer: Manufacturer's standard spacer material and construction.
3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.6 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Type recommended in writing by sealant or glass manufacturer.

D. Spacers: Type recommended in writing by sealant or glass manufacturer.

E. Edge Blocks: Type recommended in writing by sealant or glass manufacturer.

2.8 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch-minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.6 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of First Day of Business (FDOB). Wash glass as recommended in writing by glass manufacturer.

3.7 MONOLITHIC GLASS SCHEDULE

A. Clear Glass Type CTG-1: Fully tempered float glass.

1. Minimum Thickness: 6 mm.
2. Safety glazing required.

3.8 INSULATING GLASS SCHEDULE

A. Low-E-Coated, Clear Insulating Glass Type CIG-1:

1. Overall Unit Thickness: 1 inch.
2. Minimum Thickness of Each Glass Lite: 6 mm.
3. Outdoor Lite: Low-iron annealed float glass.
4. Interspace Content: Argon.
5. Indoor Lite: Low-iron annealed float glass.
6. Low-E Coating: Sputtered on second surface.

    a. Basis-of-Design Product: Subject to compliance with requirements, provide Guardian Glass SunGuard SNX 62/27, or approved equal.

7. Winter Nighttime U-Factor: 0.24 maximum.
8. Visible Light Transmittance: 64 percent minimum.
9. SHGC: 0.26 maximum.

B. Low-E-Coated, Clear Insulating Tempered Glass CTIG-1:

1. Overall Unit Thickness: 1 inch.
2. Minimum Thickness of Each Glass Lite: 6 mm.
3. Outdoor Lite: Low-iron fully tempered float glass.
4. Interspace Content: Argon.
5. Indoor Lite: Low-iron fully tempered float glass.
6. Low-E Coating: Sputtered on second surface.

    a. Basis-of-Design Product: Subject to compliance with requirements, provide Guardian Glass SunGuard SNX 62/27, or approved equal.

7. Winter Nighttime U-Factor: 0.24 maximum.

8. Visible Light Transmittance: 64 percent minimum.
9. SHGC: 0.26 maximum.
10. Safety glazing required.

C. Ceramic-Coated, Low-E, Insulating Spandrel Glass ISP-1:

1. Coating Color: As selected by Architect from manufacturer's full range.
2. Overall Unit Thickness: 1 inch.
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Low-iron fully tempered float glass.
5. Interspace Content: Argon.
6. Indoor Lite: Low-iron fully tempered float glass.
7. Low-E Coating: Sputtered on second surface.

    a. Basis-of-Design Product: Subject to compliance with requirements, provide Guardian Glass SunGuard SNX 62/27, or approved equal.

8. Opaque Coating Location: Fourth surface.
9. Winter Nighttime U-Factor: 0.24 maximum.

END OF SECTION 088000

SECTION 088300 - MIRRORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Silvered flat glass mirrors.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Mirrors: Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.

B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.

C. Samples: For each type of the following:

1. Mirrors: 12 inches square, including edge treatment on two adjoining edges.
2. Mirror Trim: 12 inches long.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of mirror.

C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For mirrors to include in maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect mirrors in accordance with mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1. Warranty Period: Five years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.

B. Source Limitations for Mirror Accessories: Obtain mirror-glazing accessories from single source.

2.2 SILVERED FLAT GLASS MIRRORS

A. Basis-of-Design Product MR: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

B. Mirrors, General: ASTM C1503.

C. Annealed Monolithic Glass Mirrors: Mirror Select Quality, clear.

1. Nominal Thickness: 6.0 mm.

D. Safety Glazing Products: For film-backed mirrors, provide products that comply with 16 CFR 1201, Category II.

2.3 MISCELLANEOUS MATERIALS

A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

C. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.4 MIRROR HARDWARE

A. Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.

1. Aluminum J-Channel Bottom and Side Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch in height, respectively, and a thickness of not less than 0.04 inch.
2. Aluminum J-Channel Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch in height, respectively, and a thickness of not less than 0.04 inch.
3. Finish: Clear bright anodized.

B. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

C. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield, expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.5 FABRICATION

A. Shop fabricate mirrors to greatest extent possible.

B. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts, so they fit closely around penetrations in mirrors.

C. Mirror Edge Treatment: Flat polished.

1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.

D. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint, as recommended in writing by film-backing manufacturer, to produce a surface free of bubbles, blisters, and other imperfections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 INSTALLATION

A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced National Glass Association (NGA) publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

1. NGA Publications: "Glazing Manual" and "Installation Techniques Designed to Prolong the Life of Flat Glass Mirrors."

B. Provide a minimum airspace of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.

C. Install mirrors with mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.

1. Aluminum J-Channels: Provide setting blocks 1/8 inch thick by 4 inches long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch wide by 3/8 inch long at bottom channel.

3.3 CLEANING AND PROTECTION

A. Protect mirrors from breakage and contaminating substances resulting from construction operations.

B. Do not permit edges of mirrors to be exposed to standing water.

C. Maintain environmental conditions that prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

D. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of First Day of Business (FDOB). Clean mirrors as recommended in writing

by mirror manufacturer and NGA's publication "Proper Procedures for Cleaning Flat Glass Mirrors."

END OF SECTION 088300

SECTION 090561.13 - MOISTURE VAPOR EMISSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Moisture vapor emission mitigation application for concrete floor slabs in preparation for floor covering installation.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 DEFINITIONS

A. MVE: Moisture vapor emission.

B. MVER: Moisture vapor emission rate.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Product Test Reports: For each MVE-control system, for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Preinstallation testing reports.

D. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used, showing:

1. Moisture and alkalinity (pH) limits and test methods.
2. Manufacturer's required bond/compatibility test procedure.

E. Testing Agency's Report:

1. Description of areas tested; include floor plans and photographs if helpful.
2. Summary of conditions encountered.
3. Moisture and alkalinity (pH) test reports.

4. Copies of specified test methods.
5. Recommendations for remediation of unsatisfactory surfaces.
6. Submit report to Architect.
7. Submit report not more than two business days after conclusion of testing.

F. Adhesive Bond and Compatibility Test Report.

1. Provide written confirmation that selected adhesives are compatible with MVE-control system.

G. Remedial Materials Product Data: Manufacturer's published data on each product to be used for remediation.

H. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Employs factory-trained personnel who are available for consultation and Project-site inspection.

B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Provide list of at least three similar projects performed by the installer within the previous five years, which used the same products and similar MVE-control system design.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating directions for storage and mixing with other components.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Comply with MVE-control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation, and other conditions affecting system installation.

1. Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than 65 deg F and not more than 85 deg F at least 48 hours before use.
2. Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE-control system manufacturer, but not less than 65 deg F or more than 85 deg F and not less than 40 or more than 60 percent relative humidity, for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.
3. Install MVE-control systems where concrete surface temperatures will remain a minimum of 5 deg F higher than the dew point for ambient temperature and relative

humidity conditions in installation areas for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to replace MVE-control systems which fail due to concrete moisture vapor or high pH.

1. Warranty includes labor and materials for replacement of MVE-control system, and for replacement of floor covering systems which occur over MVE-control system.
2. Warranty Period: 15 years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. MVE-Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:

1. MVER: Maximum 25 lb. of water/1000 sq. ft. when tested according to ASTM F1869.
2. Relative Humidity: Maximum 100 percent when tested according to ASTM F2170 using in situ probes.

B. Water-Vapor Transmission: Through MVE-control system, maximum 0.06 perm when tested according to ASTM E96/E96M.

2.2 MVE-CONTROL SYSTEM

A. Products: Subject to compliance with requirements, provide one of the following:

1. Sinak Corporation; VC-5.
2. Spray-Lock; SCP 327.

2.3 ACCESSORIES

A. Crack-Filling Material: Resin-based material recommended in writing by MVE-control system manufacturer for sealing concrete substrate crack repair.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of system indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Preinstallation Testing:

1. Testing Agency: Engage a qualified testing agency to perform tests.
2. Alkalinity Testing: Perform pH testing according to ASTM F710. Install MVE-control system in areas where pH readings are less than 7.0 and in areas where pH readings are greater than 8.5.
3. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Internal Relative Humidity Test: Using in situ probes, ASTM F2170. Install MVE-control system in locations where concrete substrates exhibit relative humidity level greater than 75 percent.

B. Concrete Substrates: Prepare and clean substrates according to MVE-control system manufacturer's written instructions.

1. Remove coatings and other substances that are incompatible with MVE-control system and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by MVE-control system manufacturer. Do not use solvents.
2. Where required by manufacturer, provide concrete surface profile complying with ICRI 310.2R CSP 3 by shot blasting using apparatus that abrades the concrete surface with shot, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
3. After shot blasting, repair damaged and deteriorated concrete according to MVE-control system manufacturer's written instructions.
4. Protect substrate voids and joints to prevent resins from flowing into or leaking through them.
5. Fill surface depressions and irregularities with patching and leveling material.
6. Fill surface cracks, grooves, control joints, and other nonmoving joints with crack-filling material.
7. Allow concrete to dry, undisturbed, for period recommended in writing by MVE-control system manufacturer after surface preparation, but not less than 24 hours.
8. Before installing MVE-control systems, broom sweep and vacuum prepared concrete.

C. Protect walls, floor openings, electrical openings, door frames, and other obstructions during installation.

3.3 INSTALLATION

A. Install MVE-control system according to manufacturer's written instructions.

1. Install primers as required to comply with manufacturer's written instructions.

B. Cure MVE-control system components according to manufacturer's written instructions. Prevent contamination or other damage during installation and curing processes.

C. After curing, examine MVE-control system for surface deficiencies. Repair surface deficiencies according to manufacturer's written instructions.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform installation inspections.

B. Installation Inspections: Inspect substrate preparation and installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete MVE-control system is installed without deficiencies.

1. Verify that surface preparation meets requirements.
2. Verify installation in accordance with manufacturer's written instructions.
3. Verify that MVE-control-system components and installation areas that evidence deficiencies are repaired according to manufacturer's written instructions.

C. MVE-control system will be considered defective if it does not pass inspections.

3.5 PROTECTION

A. Protect MVE-control system from damage, wear, dirt, dust, and other contaminants before floor covering installation. Use protective methods and materials, including temporary coverings, recommended in writing by MVE-control system manufacturer.

B. Do not allow subsequent preinstallation examination and testing for floor covering installation to damage, puncture, or otherwise compromise the MVE-control system membrane.

END OF SECTION 090561.13

SECTION 092116.23 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gypsum board shaft wall assemblies.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 ACTION SUBMITTALS

A. Product Data: For each component of gypsum board shaft wall assembly.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and support them on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

A. Environmental Limitations: Comply with gypsum-shaftliner-board manufacturer's written instructions.

B. Do not install finish panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E90 and classified according to ASTM E413 by a testing and inspecting agency.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

A. Fire-Resistance Rating: As indicated on Drawings.

B. STC Rating: As indicated on Drawings.

C. Gypsum Shaftliner Board:

1. Type X: ASTM C1396/C1396M; manufacturer's proprietary fire-resistive liner panels with paper faces, 1 inch thick, with double beveled long edges.

a. Manufacturers: Subject to compliance with requirements, provide the following:
b.

1) USG Corporation; Sheetrock Brand Gypsum Liner Panel.

2. Moisture- and Mold-Resistant, Fiberglass-Mat Faced: ASTM C1658/C1658M; manufacturer's proprietary fire-resistive liner panels with ASTM D3273 mold-resistance score of 10 as rated according to ASTM D3274, 1 inch thick, and with double beveled long edges.

a. Manufacturers: Subject to compliance with requirements, provide the following:
b.

1) USG Corporation; Sheetrock Glass-Mat Liner Panel.

D. Non-Load-Bearing Steel Framing, General: Complying with ASTM C645 requirements for metal unless otherwise indicated and complying with requirements for fire-resistance-rated assembly indicated.

1. Protective Coating: Coating with equivalent corrosion resistance of ASTM A653/A653M, G40 unless otherwise indicated.

E. Studs: Manufacturer's standard profile for repetitive, corner, and end members as follows:

1. Depth: As indicated.
2. Minimum Base-Metal Thickness: 0.030 inch.

F. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.

1. Minimum Base-Metal Thickness: Matching steel studs.

G. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

H. Finish Panels: Gypsum board as specified in Section 092900 "Gypsum Board.".

I. Sound Attenuation Blankets: As specified in Section 092900 "Gypsum Board."

2.3 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with shaft wall manufacturer's written instructions.

B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 092900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written instructions for application indicated.

C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.

1. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.
2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E1190 conducted by a qualified testing agency.

E. Reinforcing: Galvanized-steel reinforcing strips with 0.033-inch minimum thickness of base metal (uncoated).

F. Acoustical Sealant: Section 079219 "Acoustical Joint Sealants."

G. Gypsum Board Cants:

1. Gypsum Board Panels: As specified in Section 092900 "Gypsum Board," Type X, 1/2- or 5/8-inch panels.
2. Non-Load-Bearing Steel Framing: As specified in Section 092216 "Non-Structural Metal Framing."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated and manufacturer's written installation instructions.

B. Do not bridge building expansion joints with shaft wall assemblies, frame both sides of expansion joints with furring and other support.

C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.

D.

1. Reinforcing: Provide where items attach directly to shaft wall assembly as indicated on Drawings; accurately position and secure behind at least one layer of face panel.

E. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons and floor indicators, and similar items.

F. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels while maintaining continuity of fire-rated construction.

G. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

H. Control Joints: Install control joints according to ASTM C840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.

I. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.

J. Gypsum Board Cants: At projections into shaft exceeding 4 inches, install gypsum board cants covering tops of projections.

1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches o.c. with screws fastened to shaft wall framing.
2. Where non-load-bearing steel framing is required to support gypsum board cants, install framing at 24 inches o.c. and extend studs from the projection to shaft wall framing.

K. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.3 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092116.23

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.
3. Grid suspension systems for gypsum board ceilings.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; and roof rafters and ceiling joists.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation Reports: For embossed, high-strength steel studs and tracks, firestop tracks, and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association, the Steel Stud Manufacturers Association, or the Supreme Steel Framing System Association.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Notify manufacturer of damaged materials received prior to installation.

B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

C. Horizontal Deflection: For composite wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft..

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C745 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C645 requirements for metal unless otherwise indicated.
2. Protective Coating: Comply with ASTM A653/A653M, G40; or coating with equivalent corrosion resistance. Galvannealed products are unacceptable.

B. Studs and Track: ASTM C645.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. SCAFCO Steel Stud Company.

2. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection.
3. Depth: As indicated on Drawings.

C. Embossed, High Strength Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally comparable to conventional ASTM C645 steel studs and tracks.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. SCAFCO Steel Stud Company.

2. Minimum Base-Steel Thickness: As required by horizontal deflection performance requirements.
3. Depth: As indicated on Drawings.

D. Slip-Type Head Joints: Where indicated, provide one of the following:

1. Single Long-Leg Track System: ASTM C645 top track, flange length as indicated on drawings and in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
2. Double-Track System: ASTM C645 top outer tracks, inside track, flange length as indicated on drawings and in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
3. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; flange length as indicated on drawings and in thickness not less than indicated for studs and in width to accommodate depth of studs.

a. Manufacturers: Subject to compliance with requirements, provide products by the following:

1) SCAFCO Steel Stud Company.

E. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. SCAFCO Steel Stud Company.

F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Steel Thickness: 0.0179 inch.

G. Hat-Shaped, Rigid Furring Channels: ASTM C645.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. SCAFCO Steel Stud Company.

2. Minimum Base-Steel Thickness: 0.0296 inch.
3. Depth: As indicated on Drawings.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

B. Hanger Attachments to Concrete:

1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, AC193, AC58, or AC308 as appropriate for the substrate.

a. Uses: Securing hangers to structure.
b. Type: Torque-controlled, expansion anchor.
c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.

1. Depth: 2 inches.

E. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
2. Steel Studs and Tracks: ASTM C645.

a. Minimum Base-Steel Thickness: 0.0179 inch.
b. Depth: As indicated on Drawings.

3. Embossed, High-Strength Steel Studs and Tracks: ASTM C645.

a. Minimum Base-Steel Thickness: 0.0147 inch.
b. Depth: As indicated on Drawings.

4. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch deep.

a. Minimum Base-Steel Thickness: 0.0179 inch.

F. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. USG Corporation; Drywall Suspension System.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide the following:

1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

C. Smoke and Sound Seal: Compressible rectangular open-cell polyurethane.

1. Basis-of-Design Product: Subject to compliance with requirements, provide SCAFCO Steel Stud Company; Smoke and Sound Stop, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset

anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.

2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: As required by horizontal deflection performance requirements unless otherwise indicated.
2. Multilayer Application: As required by horizontal deflection performance requirements unless otherwise indicated.
3. Tile Backing Panels: As required by horizontal deflection performance requirements unless otherwise indicated.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

    a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:

    a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
    b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING CEILING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches o.c.
2. Carrying Channels (Main Runners): 48 inches o.c.
3. Furring Channels (Furring Members): 16 inches o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

    a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Do not attach hangers to steel roof deck.
5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 079219 "Acoustical Joint Sealants" for acoustical joint sealants installed in gypsum board assemblies.
3. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
4. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Gypsum wallboard.
2. Gypsum board, Type X.
3. Flexible gypsum board.
4. Mold-resistant gypsum board.
5. Gypsum board, Type C.
6. Water-resistant gypsum backing board.
7. Interior trim.
8. Aluminum trim.
9. Joint treatment materials.

B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.

C. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

1.3 QUALITY ASSURANCE

A. Mockups: Provide a Level 5 finish in-place mockup to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one wall surface, approximately 100 sq. ft. to represent surfaces and conditions.
2. Coordinate Level 5 finish mockup with mockups for interior paint and wallcoverings.
3. Install interior gypsum board so surfaces vary not more than 1/8 inch from level, and finished surfaces create an even, uninterrupted level plane.

    a. Confirm level plane of gypsum board surfaces with 8-foot long straight edge, held against the gypsum board at 48-inch and 72-inch above floor.

4. Lighting: Do not install mockup until lighting that matches conditions intended for occupants after Project completion is provided on the surfaces to receive mockup.
5. Mockup shall be reviewed by Architect standing 60 inches from finish surface, viewing both perpendicular to finish and from the side.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
7. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.4 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of gypsum panel and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

C. Verify ceiling and wall materials comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.4 INTERIOR GYPSUM BOARD

A. Gypsum Wallboard: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. USG Corporation; USG Sheetrock Brand EcoSmart Panels Firecode 30.

2. Thickness: 5/8 inch.
3. Long Edges: Tapered.

B. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

C. Flexible Gypsum Board: ASTM C1396/C1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.

1. Manufacturers: Subject to compliance with requirements, provide the following:

a. Panel Rey; Flex Rey Gypsum Board.

2. Thickness: 1/4 inch.
3. Long Edges: Tapered.

D. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.5 SPECIALTY GYPSUM BOARD

A. Gypsum Board, Type C: ASTM C1396/C1396M. Manufactured to have increased fire-resistive capability.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. USG Corporation; USG Sheetrock Brand EcoSmart Panels Firecode C.

2. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
3. Long Edges: Tapered.

2.6 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.

1. Core: 5/8 inch, Type X.
2. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.7 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: Paper-faced galvanized-steel sheet.
2. Shapes:

a. Cornerbead.
b. Expansion (control) joint.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Fry Reglet Corporation.
b. Gordon Inc.
c. Pittcon Industries.
d. Tamlyn.

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221, Alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.8 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

D. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

2.9 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

C. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

D. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

E. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

A. Comply with ASTM C840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Installation Tolerance: Install interior gypsum board so surfaces vary not more than 1/8 inch from level, and finished surfaces create an even, uninterrupted level plane.

1. Confirm level plane of gypsum board surfaces with 8-foot long straight edge, held against the gypsum board at 48-inch and 72-inch above floor.

B. Install interior gypsum board in the following locations:

1. Wallboard Type: Vertical surfaces unless otherwise indicated.
2. Type X: Where required for fire-resistance-rated assembly and as indicated on Drawings.
3. Flexible Type: Apply in double layer at curved assemblies.
4. Mold-Resistant Type: As indicated on Drawings.
5. Type C: Where required for specific fire-resistance-rated assembly indicated.

C. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels as indicated or required by fire-resistance-rated assembly, and minimize end joints.

a. Stagger abutting end joints not less than one framing member in alternate courses of panels.

3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

D. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

E. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch- long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.

3.4 INSTALLATION OF TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.

B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLATION OF TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on Drawings, or according to ASTM C840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners unless otherwise indicated.

D. Exterior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.

E. Aluminum Trim: Install in locations indicated on Drawings.

3.6 FINISHING OF GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile.
3. Level 3: Not used.
4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
5. Level 5: Where applied wall coverings occur, where applied vinyl graphics occur, where paint sheen other than flat or eggshell occurs, or where indicated on Drawings.

E. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

A. Level 5 Finish Verification: Owner and Architect may, at any time and any number of times during gypsum board installation, review Level 5 finish for compliance with requirements.

1. Finish shall be reviewed by Architect standing 60 inches from finish surface, viewing both perpendicular to finish and from the side.

B. If review indicates Level 5 finish does not comply with specified requirements, remove noncomplying materials, prepare surfaces, and reinstall gypsum board and Level 5 finish to comply with requirements.

3.8 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor tile.
2. Wall tile.
3. Waterproof/crack isolation membranes.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
3. Section 092900 "Gypsum Board" for glass-mat, water-resistant backer board.

1.2 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. Face Size: Actual tile size, excluding spacer lugs.

C. Module Size: Actual tile size plus joint width indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

C. Samples for Initial Selection: For tile, grout, and accessories involving color selection.

D. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.
2. Metal edge strips in 6-inch lengths.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

C. Product Certificates: For each type of product.

D. Product Test Reports: For tile-setting and -grouting products.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has successfully completed tile installations similar in material, design, and extent to that indicated on Project.

B. Mockups: Build in-place mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of each type of floor tile installation.
2. Build mockup of each type of wall tile installation.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

2.2 TILE PRODUCTS

A. Basis of Design Products (TL-1, TL-2, TL-3): Subject to compliance with the requirements, provide products specified on the Finish Schedule.

2.3 WATERPROOF MEMBRANES

A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

1. Products: Subject to compliance with requirements, provide the following:

a. Laticrete International, Inc.; LATICRETE HYDRO BAN.

2.4 SETTING MATERIALS

A. Mortar Bed: Polymer-fortified blend of polymers, portland cement and graded aggregates.

1. Manufacturers: Subject to compliance with requirements, provide the following:

a. Laticrete International, Inc.; LATICRETE 3701 Fortified Mortar Bed.

B. Improved Modified Dry-Set Mortar (Thinset): ANSI A118.15.

1. Manufacturers: Subject to compliance with requirements, provide the following:

a. Laticrete International, Inc.; LATICRETE 254 Platinum.

2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.15.

2.5 GROUT MATERIALS

A. Basis of Design Products (GT-1): Subject to compliance with the requirements, provide products specified on the Finish Schedule.

2.6 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Metal Edge Strips: Subject to compliance with the requirements, provide products specified on the Finish Schedule.

C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

D. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

1. Manufacturers: Subject to compliance with requirements, provide the following:

a. Laticrete International, Inc.; LATICRETE STONETECH Heavy Duty Grout Sealer.

2.7 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.

    a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproof membrane by applying a mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION OF CERAMIC TILE

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:

   a.
   b. Tile floors in wet areas.
   c. Tile floors consisting of tiles 8 by 8 inches or larger.
   d. Tile floors consisting of rib-backed tiles.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

I. Metal Edge Strips: Install at locations indicated and where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.

J. Floor Sealer: Apply floor sealer to grout joints in tile floors according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 INSTALLATION OF WATERPROOF/CRACK ISOLATION MEMBRANE

A. Install waterproof/crack isolation membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

B. Allow waterproof/crack isolation membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

C. Install waterproof/crack isolation membrane at locations indicated on drawings, and as follows:

1. Shower floor and shower walls.

3.5 ADJUSTING AND CLEANING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.6 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

END OF SECTION 093013

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for interior ceilings.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.

    a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:

    a. Lighting fixtures.
    b. Diffusers.
    c. Grilles.
    d. Speakers.
    e. Sprinklers.
    f. Access panels.

g. Perimeter moldings.

7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
8. Minimum Drawing Scale: 1/4 inch = 1 foot.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class A according to ASTM E1264.
2. Smoke-Developed Index: 50 or less.

2.3 ACOUSTICAL PANELS

A. Source Limitations for Acoustical Panel Ceilings: Obtain each type, color, and pattern from a single source.

1. Obtain each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
2. Obtain suspension system, trims, and installation accessories that comply with performance and sustainability requirements, and that are recommended or provided by the manufacturer.

B. Basis-of-Design Products (ACT-1, ACT-2): Subject to compliance with requirements, provide products specified on the Finish Schedule.

2.4 METAL SUSPENSION SYSTEM

A. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M and designated by type, structural classification, and finish indicated.

B. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 9/16-inch-wide metal caps on flanges.

1. Structural Classification: Intermediate-duty system.
2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
3. Face Design: Flat, flush.
4. Cap Material: Cold-rolled steel.
5. Cap Finish: Painted white.

2.5 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.

2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch- diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch-thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 coating designation; with bolted connections and 5/16-inch-diameter bolts.

2.6 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

A. Install acoustical panel ceilings according to ASTM C636/C636M and manufacturer's written instructions.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
7. Do not attach hangers to steel deck tabs.
8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
9. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
2. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.

B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.5 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoset-rubber base.
2. Rubber molding accessories.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.5 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:

1. 48 hours before installation.
2. During installation.

3. 48 hours after installation.

B. After installation and until First Day of Business (FDOB), maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOSET-RUBBER BASE

A. Basis-of-Design Product (RB-1): Subject to compliance with the requirements, provide products specified on the Finish Schedule.

B. Product Standard: ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).

1. Style and Location:

a. Style A, Straight: Provide in areas with carpet.
b. Style B, Cove: Provide in areas with resilient floor coverings.

C. Lengths: Coils in manufacturer's standard length.

D. Outside Corners: Job formed.

E. Inside Corners: Job formed.

2.2 RUBBER MOLDING ACCESSORY

A. Description: Rubber transition strips.

B. Profile and Dimensions: As indicated.

C. Locations: Provide rubber molding accessories in areas indicated.

D. Colors and Patterns: Match Architect's sample.

2.3 INSTALLATION MATERIALS

A. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

    a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

    a. Miter corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from surfaces.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

END OF SECTION 096513

SECTION 096516 - RESILIENT SHEET FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Unbacked rubber sheet flooring.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of resilient sheet flooring.

1. Include sheet flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

C. Samples: For each exposed product and for each color, texture, and pattern specified, in manufacturer's standard size, but not less than 6-by-9-inch sections.

D. Product Schedule: For resilient sheet flooring. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of resilient sheet flooring to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Resilient Sheet Flooring: Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, in roll form and in full roll width for each type, color, and pattern of flooring installed.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for resilient sheet flooring installation and seaming method indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by resilient sheet flooring manufacturer for installation techniques required.

B. Mockups: Build in-place mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Coordinate mockups in this Section with mockups specified in other Sections.

a. Size: Minimum 100 sq. ft. for each type, color, and pattern in locations directed by Architect.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store resilient sheet flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store rolls upright.

1.8 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F, in spaces to receive resilient sheet flooring during the following periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After installation and until First Day of Business (FDOB), maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Close spaces to traffic during resilient sheet flooring installation.

D. Close spaces to traffic for 48 hours after resilient sheet flooring installation.

E. Install resilient sheet flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient sheet flooring, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 UNBACKED RUBBER SHEET FLOORING

A. Basis-of-Design Products (RF-1): Subject to compliance with requirements, provide products specified on the Finish Schedule.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient sheet flooring manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient sheet flooring and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient sheet flooring.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to resilient sheet flooring manufacturer's written instructions to ensure adhesion of resilient sheet flooring.

B. Concrete Substrates: Prepare according to ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient sheet flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing.
4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a relative humidity level measurement within range recommended in writing by manufacturer.

C. Where alkalinity and moisture testing indicates concrete substrate does not comply with resilient sheet flooring and adhesive manufacturer requirements, install moisture vapor emission control system in accordance with Section 090561.13 “Moisture Vapor Emission Control.”

D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

E. Do not install resilient sheet flooring until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.

F. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient sheet flooring.

3.3 RESILIENT SHEET FLOORING INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient sheet flooring.

B. Unroll resilient sheet flooring and allow it to stabilize before cutting and fitting.

C. Lay out resilient sheet flooring as follows:

1. Maintain uniformity of flooring direction.
2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in flooring substrates.
3. Match edges of flooring for color shading at seams.
4. Avoid cross seams.

D. Scribe and cut resilient sheet flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend resilient sheet flooring into toe spaces, door reveals, closets, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient sheet flooring as marked on substrates. Use chalk or other nonpermanent marking device.

G. Install resilient sheet flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.

H. Adhere resilient sheet flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient sheet flooring.

B. Perform the following operations immediately after completing resilient sheet flooring installation:

1. Remove adhesive and other blemishes from surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient sheet flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient sheet flooring until First Day of Business (FDOB).

END OF SECTION 096516

SECTION 096723 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Resinous flooring.
2. Anti-static resinous flooring.

B. Related Sections:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 099600 “High-Performance Coatings” for concrete floor sealer.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review manufacturer's written instructions for substrate preparation and environmental conditions affecting resinous flooring installation.
2. Review manufacturer's written instructions for installing resinous flooring systems.
3. Review protection measures for adjacent construction and installed flooring, floor drainage requirements, curbs, base details, and so forth.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's technical data, installation instructions, and recommendations for each resinous flooring component required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For each resinous flooring component.

C. Material Test Reports: For each resinous flooring system, by a qualified testing agency.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

B. Mockups: Build in-place mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Apply full-thickness mockups on 96-inch-square floor area selected by Architect.

a. Include 96-inch length of integral cove base with inside and outside corner.

2. Simulate finished lighting conditions for Architect's review of mockups.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring installation.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring installation.

C. Close spaces to traffic during resinous flooring installation and for 24 hours after installation unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Flammability: Self-extinguishing in accordance with ASTM D635.

2.2 RESINOUS FLOORING

A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, aggregate-filled, resin-based monolithic floor surfacing designed to produce a seamless floor.

1. Basis-of-Design Product (RES-1): Subject to compliance with requirements, provide products specified on the Finish Schedule.

B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

C. Primer: Type recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated.

2.3 ANTI-STATIC RESINOUS FLOORING

A. Anti-Static Resinous Flooring: 100 percent solid, chemical resistant seamless epoxy floor coating system designed to dissipate electrostatic charge.

1. Basis-of-Design Product (CONC-2): Subject to compliance with requirements, provide products specified on the Finish Schedule.

B. Source Limitations: Obtain primary anti-static resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

C. Primer: Type recommended in writing by anti-static resinous flooring manufacturer for substrate and resinous flooring system indicated.

2.4 ACCESSORIES

A. Moisture Vapor Emission Control System: As recommended in writing by resinous flooring manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resinous flooring systems.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare and clean substrates in accordance with resinous flooring manufacturer's written instructions for substrate indicated to ensure adhesion.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Roughen concrete substrates as follows:

a. Comply with requirements in SSPC-SP 13/NACE No. 6, with a Concrete Surface Profile of 2 in accordance with ICRI Technical Guideline No. 310.2R, unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete in accordance with resinous flooring manufacturer's written instructions.
3. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a relative humidity level measurement within range recommended in writing by manufacturer.

4. Alkalinity and Adhesion Testing: Perform tests recommended in writing by resinous flooring manufacturer. Proceed with installation only after substrate alkalinity is not less than 6 or more than 8 pH unless otherwise recommended in writing by flooring manufacturer.

C. Where alkalinity and moisture testing indicates concrete substrate does not comply with resinous flooring manufacturer requirements, install manufacturer-provided moisture vapor emission control system.

D. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates in accordance with manufacturer's written instructions.

1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring in accordance with manufacturer's written instructions.

E. Resinous Materials: Mix components and prepare materials in accordance with resinous flooring manufacturer's written instructions.

3.3 INSTALLATION

A. Apply components of resinous flooring system in accordance with manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness specified.

1. Coordinate installation of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
2. Cure resinous flooring components in accordance with manufacturer's written instructions. Prevent contamination during installation and curing processes.
3. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

B. Primer: Apply primer over prepared substrate at spreading rate recommended in writing by manufacturer.

C. Field-Formed Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring coats. Apply in accordance with manufacturer's written instructions and details, including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.

1. Integral Cove Base: Height as indicated on drawings.

D. Topcoats: Apply topcoats in number indicated for flooring system specified, at spreading rates recommended in writing by manufacturer, and to produce wearing surface specified.

3.4 FIELD QUALITY CONTROL

A. Material Sampling: Owner may, at any time and any number of times during resinous flooring installation, require material samples for testing for compliance with requirements.

1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.

3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reinstall flooring materials to comply with requirements.

B. Core Sampling: At Owner's direction and at locations designated by Owner, take one core sample per 1000 sq. ft. of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring. Correct deficiencies in installed flooring as indicated by testing.

3.5 PROTECTION

A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 096723

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modular carpet tile.
2. Walk-off mat.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:

a. Review delivery, storage, and handling procedures.
b. Review ambient conditions and ventilation procedures.
c. Review subfloor preparation procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.

B. Shop Drawings: For carpet tile installation, plans showing the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
2. Carpet tile type, color, and dye lot.
3. Type of subfloor.
4. Type of installation.
5. Pattern of installation.
6. Pattern type, location, and direction.
7. Pile direction.

8. Type, color, and location of insets and borders.
9. Type, color, and location of edge, transition, and other accessory strips.
10. Transition details to other flooring materials.

C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.

D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

E. Sustainable Product Certification: Provide ANSI/NSF 140 certification for carpet products.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:

1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

B. Mockups: Build in-place mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups at locations and in sizes shown on Drawings.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Carpet and Rug Institute's CRI 104.

1.9 FIELD CONDITIONS

A. Comply with the Carpet and Rug Institute's CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.10 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, the following:

a. More than 10 percent edge raveling, snags, and runs.
b. Dimensional instability.
c. Excess static discharge.
d. Loss of tuft-bind strength.
e. Loss of face fiber.
f. Delamination.

3. Warranty Period: 15 years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 CARPET TILE

A. Basis-of-Design Products (CPT-1, CPT-2): Subject to compliance with requirements, provide products specified on the Finish Schedule.

2.2 WALK-OFF MAT

A. Basis-of-Design Products (WOM-1): Subject to compliance with requirements, provide products specified on the Finish Schedule.

2.3 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

C. Metal Edge/Transition Strips: Profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

1. Basis-of-Design Product: Subject to compliance with requirements, provide products specified on the Finish Schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

B. Examine carpet tile for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a relative humidity level measurement within range recommended in writing by manufacturer.
b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

D. Where alkalinity and moisture testing indicates concrete substrate does not comply with tile carpeting and adhesive manufacturer requirements, install moisture vapor emission control system in accordance with Section 090561.13 “Moisture Vapor Emission Control.”

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns indicated on Drawings.

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

H. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with the Carpet and Rug Institute's CRI 104, Section 13.7.

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 097200 - WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wallpaper.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data on physical characteristics, durability, fade resistance, and fire-test-response characteristics.

B. Shop Drawings: Show location and extent of each wall-covering type. Indicate seams and termination points.

C. Samples: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by 36 inches long in size.

D. Product Schedule: For wall coverings. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each wall covering, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For wall coverings to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wall-Covering Materials: For each type, color, texture, and finish, full width by length to equal to 5 percent of amount installed.

1.7 QUALITY ASSURANCE

A. Mockups: Build in-place mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for installation.

1. Build mockups for each type of wall covering on each substrate required. Comply with requirements in ASTM F1141 for appearance shading characteristics.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for occupants after Project completion during the remainder of the construction period.

B. Lighting: Do not install wall covering until lighting that matches conditions intended for occupants after Project completion is provided on the surfaces to receive wall covering.

C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.1 WALLPAPER

A. Basis-of-Design Product (WC-1): Subject to compliance with requirements, provide products specified on the Finish Schedule.

2.2 ACCESSORIES

A. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.

B. Primer/Sealer: Mildew resistant, complying with requirements in Section 099123 "Interior Painting" and recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation surfaces being true in plane and vertical and horizontal alignment, maximum moisture content, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, and mildew.

C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.

1. Gypsum Board: Apply primer/sealer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.

D. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

E. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.3 INSTALLATION OF WALL COVERING

A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.

B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.

C. Install strips in same order as cut from roll.

D. Install wall covering without lifted or curling edges and without visible shrinkage.

E. Match pattern 72 inches above the finish floor.

F. Install seams vertical and plumb at least 6 inches from outside corners and 3 inches from inside corners unless a change of pattern or color exists at corner. Horizontal seams are not permitted.

G. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without overlaps or gaps between strips.

H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

3.4 CLEANING

A. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.

B. Use cleaning methods recommended in writing by wall-covering manufacturer.

C. Replace strips that cannot be cleaned.

D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 097200

SECTION 098433 - SOUND-ABSORBING WALL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes shop-fabricated, acoustical panel units tested for acoustical performance, including the following:

1. Sound-absorbing wall panels.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 DEFINITIONS

A. NRC: Noise Reduction Coefficient.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include panel edge, core material, and mounting indicated.

B. Shop Drawings: For unit assembly and installation.

1. Include plans, elevations, sections, and mounting devices and details.
2. Include details at panel head, base, joints, and corners, and details at ceiling, floor base, and wall intersections. Indicate panel edge profile and core materials.
3. Include details at cutouts and penetrations for other work.

C. Samples for Initial Selection: For each type of sound absorbing wall unit.

1. Include Samples of hardware and accessories involving color or finish selection.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets, switches, and thermostats.
2. Items penetrating or covered by units including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Alarms.
e. Sprinklers.
f. Access panels.

3. Show operation of hinged and sliding components covered by or adjacent to units.

B. Product Certificates: For each type of unit.

C. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of unit to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mounting Devices: Full-size units equal to 5 percent of amount installed, but no fewer than five devices, including unopened adhesives.

1.8 QUALITY ASSURANCE

A. Mockups: Build in-place mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials, fabrication, and installation.

1. Build mockup of typical wall area, with minimum two adjacent sound-absorbing wall units.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install units until a permanent level of lighting is provided on surfaces to receive the units.

C. Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication and indicate them on Shop Drawings.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace units and components that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to the following:

a. Acoustical performance.
b. Warping of core.

2. Warranty Period: Two years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: 25 or less.
    b. Smoke-Developed Index: 450 or less.

2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 Method B Protocol or NFPA 286.

2.2 SOUND-ABSORBING WALL UNITS

A. Sound-Absorbing Wall Panel: Thermally bonded polyester fiber.

1. Basis-of-Design Product (AWP-1 through AWP-3): As indicated on the Finish Schedule.

2.3 MATERIALS

A. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:

1. Metal Clips or Bar Hangers: Manufacturer's standard two-part metal "Z" clips, with one part of each clip mechanically attached to back of unit and the other part to substrate, designed to permit unit removal.

2.4 FABRICATION

A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated.

B. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:

1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

3.3 INSTALLATION TOLERANCES

A. Variation from Plumb and Level: Plus or minus 1/16 inch in 48 inches, noncumulative.

B. Variation of Joint Width: Not more than 1/16-inch variation from hairline in 48 inches, noncumulative.

3.4 CLEANING

A. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 098433

SECTION 098436 - SOUND-ABSORBING CEILING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes shop-fabricated, acoustical panel units tested for acoustical performance, including the following:

1. Sound-absorbing ceiling panels.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 DEFINITIONS

A. NRC: Noise Reduction Coefficient.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include panel edge, core material, and mounting indicated.

B. Shop Drawings: For unit assembly and installation.

1. Include reflected ceiling plans, elevations, sections, and mounting devices and details.
2. Include details at joints and corners; and details at ceiling intersections and intersections with walls. Indicate panel edge profile and core materials.

C. Samples for Initial Selection: For each type of panel.

1. Include Samples of hardware and accessories involving color or finish selection.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets.
2. Suspended ceiling components above ceiling units.
3. Structural members to which suspension devices will be attached.
4. Items penetrating or covered by units including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Alarms.
    e. Sprinklers.
    f. Access panels.

5. Show operation of hinged and sliding components covered by or adjacent to units.

B. Product Certificates: For each type of unit.

C. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of unit to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mounting Devices: Full-size units equal to 5 percent of amount installed, but no fewer than five devices.

1.8 QUALITY ASSURANCE

A. Mockups: Build in-place mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials, fabrication, and installation.

1. Build mockup of typical ceiling area, with minimum two adjacent sound-absorbing ceiling panels, and two adjacent sound-absorbing baffle panels.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install units until a permanent level of lighting is provided on surfaces to receive the units.

C. Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace units and components that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Acoustical performance.
b. Warping of core.

2. Warranty Period: Two years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: 25 or less.
    b. Smoke-Developed Index: 450 or less.

2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 286.

2.2 SOUND-ABSORBING CEILING UNITS

A. Sound-Absorbing Ceiling Panel: Thermally-bonded polyester fiber.

1. Basis-of-Design Product: As indicated on the Finish Schedule.
2. Panel Shape: Flat.
3. Mounting: Mounted with manufacturer's standard aircraft cable suspension system, secured to substrate.
4. Edge Profile: Square.
5. Corner Detail in Elevation: Square with continuous edge profile indicated.
6. Acoustical Performance: Sound absorption NRC of 1.05 for 2-inch thickness.
7. Nominal Overall Panel Thickness: As indicated on Drawings.

2.3 MATERIALS

A. Mounting Devices: Concealed on top edge of unit, recommended by manufacturer to support weight of unit.

2.4 FABRICATION

A. Measure each area and establish layout of panels and joints of sizes indicated on Drawings within a given area.

B. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:

1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units in locations indicated. Unless otherwise indicated, install units with edges in alignment with walls and other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

3.3 INSTALLATION TOLERANCES

A. Variation from Alignment with Surfaces: Plus or minus 1/16 inch in 48 inches, noncumulative.

B. Variation from Level or Slope: Plus or minus 1/16 inch.

3.4 CLEANING

A. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 098436

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Primers.
2. Finish coatings.
3. Floor sealers and paints.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 055000 "Metal Fabrications" for shop priming metal fabrications.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples: For each type of topcoat product.

C. Samples for Initial Selection: For each type of topcoat product.

D. Product Schedule: Use same designations indicated on Drawings and in the Exterior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint Products: 5 percent, but not less than 1 gal. of each material and color applied.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:

1. Benjamin Moore & Co.

B. Source Limitations: Obtain each paint product from single source from single manufacturer.

2.2 PAINT PRODUCTS, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturer for use in paint system and on substrate indicated.

2.3 PRIMERS

A. Water-Based, Rust-Inhibitive Primer: Corrosion-resistant, water-based-emulsion primer formulated for resistance to flash rusting when applied to cleaned, exterior ferrous metals subject to mildly corrosive environments.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Benjamin Moore & Co.; Ultra Spec HP Acrylic Metal Primer, or approved equal.

B. Water-Based, Galvanized-Metal Primer: Corrosion-resistant, pigmented, acrylic primer; formulated for use on cleaned/etched, exterior, galvanized metal to prepare it for subsequent water-based coatings.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Benjamin Moore & Co.; Ultra Spec HP Acrylic Metal Primer, or approved equal.

2.4 FINISH COATINGS

A. Exterior Latex Paint, Gloss: Water-based, pigmented, acrylic-copolymer-emulsion coating formulated for alkali, mold, microbial, scrub, blocking (sticking of two painted surfaces), and water resistance and for use on exterior, primed, wood and metal trim, sashes, frames, and doors.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Benjamin Moore & Co.; Ultra Spec EXT Gloss Finish, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems specified in this Section.

D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer.

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 INSTALLATION

A. Apply paints in accordance with manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Tint undercoats same color as topcoat but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view:

a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor shall pay for testing and apply additional

coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
3. Allow empty paint cans to dry before disposal.
4. Collect waste paint by type and deliver to recycling or collection facility.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. Steel and Iron Substrates:

1. Latex System:

a. Prime Coat: Water-based, rust-inhibitive primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, gloss.

B. Galvanized-Metal Substrates:

1. Latex System:

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, gloss.

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Primers.
2. Water-based finish coatings.
3. Dry fall coatings.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
3. Section 133419 “Metal Building Systems” for shop priming at metal building systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples: For each type of topcoat product.

C. Samples for Initial Selection: For each type of topcoat product.

D. Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint Products: 5 percent, but not less than 1 gal. of each material and color applied.

1.4 QUALITY ASSURANCE

A. Mockups: Apply in-place mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system.

    a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
    b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

    a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:

1. Benjamin Moore & Co.

B. Source Limitations: Obtain each paint product from single source from single manufacturer.

2.2 PAINT PRODUCTS, GENERAL

A. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

2.3 PRIMERS

A. Interior, Institutional Low-Odor/VOC Primer Sealer: Water-based primer sealer with low-odor characteristics and a VOC of less than 10 grams per liter for use on new interior plaster, concrete, and gypsum wallboard surfaces that are subsequently to be painted with latex finish coats.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Benjamin Moore Ultra Spec 500 Primer, or approved equal.

2.4 WATER-BASED FINISH COATS

A. Interior, Latex, Institutional Low Odor/VOC: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.

1. Basis-of-Design Product (PT-1 through PT-4, PT-6): Subject to compliance with requirements, provide products specified on the Finish Schedule.

B. Interior, Latex, High-Performance Architectural Coating, Semigloss: High-performance architectural latex coating providing a significantly higher level of performance than conventional latex paints in the areas of scrub resistance, burnish resistance, and ease of stain removal.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Benjamin Moore Ultra Spec HP D.T.M. Acrylic Semi-Gloss, or approved equal.

C. Interior, Waterbased Epoxy, High-Performance Architectural Coating: High-performance waterbased epoxy coating providing a significantly higher level of performance than conventional latex paints in the areas of scrub resistance, burnish resistance, and ease of stain removal.

1. Basis-of-Design Product (PT-5): Subject to compliance with requirements, provide products specified on the Finish Schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 INSTALLATION

A. Apply paints according to manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in occupied spaces:

a. Equipment, including panelboards.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
h. Other items as directed by Architect.

2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry-Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
3. Allow empty paint cans to dry before disposal.
4. Collect waste paint by type and deliver to recycling or collection facility.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. Steel Substrates:

1. High-Performance Architectural Latex System:

a. Prime Coat: Shop primer provided by manufacturer of item scheduled to receive interior paint system.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, high-performance architectural coating.

1) Sheen: Semigloss.

B. Galvanized-Metal Substrates:

1. High-Performance Architectural Latex System:

a. Prime Coat: Shop primer provided by manufacturer of item scheduled to receive interior paint system.

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, high-performance architectural coating.

1) Sheen: Semigloss.

C. Gypsum Board Substrates:

1. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low odor/VOC.

1) Sheen: As directed by Architect.

2. Waterbased Epoxy, High-Performance Architectural Coating System:

a. Prime Coat: Interior latex primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, waterbased epoxy, high-performance architectural coating.

1) Sheen: As directed by Architect.

END OF SECTION 099123

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of high-performance coating systems on the following substrates:

1. Interior Substrates:

a. Concrete floor sealer.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 096723 “Resinous Flooring” for anti-static resinous flooring at concrete.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product indicated.

C. Samples for Verification: For each type of coating system and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports: For high-performance coatings.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: 5 percent, but not less than 1 gal. of each material applied.

1.5 QUALITY ASSURANCE

A. Mockups: Apply in-place mockups of each coating system indicated to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each coating system.

a. Floor Surfaces: Provide samples of at least 100 sq. ft.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Slip Resistance: Dynamic Coefficient of Friction (DCOF) not less than 0.60 for high-performance coatings applied to floor surfaces.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. Material Compatibility:

1. Materials for use within each coating system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a coating system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
3. Products shall be of same manufacturer for each coat in a coating system.

2.3 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions.

1. Use applicators and techniques suited for coating and substrate indicated.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Contractor shall touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

B. Tests: Engage a qualified testing agency to perform the following tests on representative areas of installed high-performance coatings applied to floor surfaces.

1. Slip-Resistance Test: In accordance with ANSI A326.3 (Wet Test).

a. Perform a minimum of two tests in areas directed by Architect.

C. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Concrete Substrates, Horizontal Surfaces.

1. Basis-of-Design Product (CONC-1): Subject to compliance with requirements, provide products specified on the Finish Schedule.

END OF SECTION 099600

SECTION 102600 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Corner guards.
2. Abuse-resistant wall coverings.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 066400 “Plastic Paneling” for FRP wall panels.
3. Section 087100 "Door Hardware" for metal protective trim units, according to BHMA A156.6, used for armor, kick, mop, and push plates.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For each type of wall and door protection showing locations and extent.

1. Include plans, elevations, sections, and attachment details.

C. Samples for Initial Selection: For each type of wall and door protection indicated, in each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.

1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of wall- and door-protection units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.

2. Warranty Period: Five years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain wall- and door-protection products from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

2.3 CORNER GUARDS

A. Surface-Mounted, Metal Corner Guards: Fabricated as one piece from formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.

1. Basis-of-Design Product (CGD-1): Subject to compliance with requirements, provide products specified on the Finish Schedule.
2. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes.

2.4 ABUSE-RESISTANT WALL COVERINGS

A. Plastic Laminate Wall Surfacing:

1. Basis-of-Design Product (PLAM-2): Subject to compliance with requirements, provide products specified on the Finish Schedule.

2.5 MATERIALS

A. Fasteners: Stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.

2.6 FABRICATION

A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.

2.7 FINISHES

A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Complete finishing operations, including painting, before installing wall and door protection.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

B. Abuse-Resistant Wall Covering: Install top and edge moldings, corners, and divider bars as required for a complete installation.

3.4 CLEANING

A. Immediately after completion of installation, clean wall and door protection items using a manufacturer’s recommended cleaning agent.

END OF SECTION 102600

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Public-use shower room accessories.
3. Under lavatory guards.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 088300 "Mirrors" for frameless mirrors.

1.2 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.

    a. For grab bars and shower seats, indicate compliance with specified structural-performance requirements.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, visible silver spoilage defects.
2. Warranty Period: 10 years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Design accessories and fasteners to comply with the following requirements:

1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.
2. Shower Seats: Installed units are able to resist 250 lbf applied in any direction and at any point.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Source Limitations: Obtain each type of public-use washroom accessory from single source from single manufacturer.

B. Toilet Tissue (Jumbo-Roll) Dispenser:

1. Basis-of-Design Product TPD: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

C. Automatic Paper Towel (Roll) Dispenser:

1. Basis-of-Design Product PTD: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

D. Tabletop Towel Dispenser:

1. Basis-of-Design Product 9: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

E. Waste Receptacle:

1. Basis-of-Design Product WR: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

F. Automatic Soap Dispenser, Surface Mounted:

1. Basis-of-Design Product SD: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

G. Automatic Soap Dispenser, Deck Mounted:

1. Basis-of-Design Product 1: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

H. Grab Bar:

1. Basis-of-Design Product GB-1 through GB-3, 6: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

I. Sanitary-Napkin Disposal Unit:

1. Basis-of-Design Product SND, SNDR: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

J. Seat-Cover Dispenser:

1. Basis-of-Design Product SCD: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

K. Hook:

1. Basis-of-Design Product RH: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

L. Shower Soap Dispenser:

1. Basis-of-Design Product 4: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

2.3 PUBLIC-USE SHOWER ROOM ACCESSORIES

A. Source Limitations: Obtain each type of public-use shower room accessory from single source.

B. Shower Curtain Rod:

1. Basis-of-Design Product 3: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

C. Shower Curtain:

1. Basis-of-Design DR-1: As indicated on Sheet A12.0 Finish Schedule, or approved equal.
2. Size: Minimum 6 inches wider than opening by 72 inches high.
3. Grommets: Corrosion resistant at minimum 6 inches o.c. through top hem.

D. Shower Curtain Hooks:

1. Basis-of-Design Product 2: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

E. Folding Shower Seat:

1. Basis-of-Design Product 5: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

2.4 UNDERLAVATORY GUARDS

A. Underlavatory Guard:

1. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
2. Material and Finish: Antimicrobial, molded plastic, white.

2.5 MATERIALS

A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch-minimum nominal thickness unless otherwise indicated.

B. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.

2.6 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

1. Remove temporary labels and protective coatings.

B. Grab Bars: Install to comply with specified structural-performance requirements.

C. Shower Seats: Install to comply with specified structural-performance requirements.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

END OF SECTION 102800

SECTION 104116 – EMERGENCY KEY CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emergency key cabinets.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 PREINSTALLATION CONFERENCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to emergency key cabinets including, but not limited to, the following:

a. Location and rough-in requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Show cabinet type, and trim style. Include roughing-in dimensions and details showing recessed-mounting method and relationships of box and trim to surrounding construction.

B. Samples: For each type of exposed finish required.

1.4 COORDINATION

A. Coordinate size of emergency key cabinets to ensure that type and capacity of stored keys indicated are accommodated.

B. Coordinate sizes and locations of emergency key cabinets with wall depths.

PART 2 - PRODUCTS

2.1 EMERGENCY KEY CABINET

A. Emergency Key Cabinet: Subject to compliance with requirements, provide Knox Box Model 3200.

1. Mounting: Recessed mount.
2. Door Material: 1/2-inch solid steel plate, with stainless steel door hinge and interior gasket seal.
3. Housing: 1/4-inch plate.
4. Lock: UL listed, double-action rotating tumblers and hardened steel pins accessed by a biased cut key. Lock has 1/8-inch-thick lock cover.
5. Finish: Manufacturer standard powder coating.

a. Color: As selected by Architect from manufacturer’s standard colors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls for suitable framing depth and blocking where recessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for recessed emergency key cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install emergency key cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Emergency Key Cabinets: Fasten cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide recessed emergency key cabinets.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as emergency key cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of emergency key cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

C. Touch up marred finishes or replace emergency key cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by emergency key cabinet manufacturer.

D. Replace emergency key cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104116

SECTION 104300 – EMERGENCY AID SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Automated external defibrillator (AED).
2. First aid kit (FAK).
3. Sharps container (SC).
4. Blood borne pathogen kit (BBPK).

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 PREINSTALLATION CONFERENCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to emergency aid specialties including, but not limited to, the following:

a. Location and rough-in requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 COORDINATION

A. Coordinate installation of blocking, bracing, and backing to receive products of this Section.

B. Supply installation templates, verify required reinforcing, and recessed anchorage devices on time to installers of related work who will receive products of this Section.

PART 2 - PRODUCTS

2.1 AUTOMATED EXTERNAL DEFIBRILLATOR (AED)

A. Surface-Mounted Device: Model No. AED3 manufactured by Zoll, www.zoll.com

1. No substitutions accepted.
2. Size: 17.5 inches by 17.5 inches by 9 inches.

2.2 FIRST AID KIT (FAK)

A. Cabinets:

1. Type 1: 4-Shelf First Aid Kit.

    a. Size: 22 inches by 19 inches by 5.5 inches.
    b. Recessed when installed in gypsum boards walls.

2. Type 2: 3-Shelf First Aid Kit.

    a. Size: 16 inches by 19 inches by 5.5 inches.
    b. Recessed when installed in gypsum boards walls.

3. Manufacturer: Cintas, www.cintas.com

    a. Contact: Reese Dole, doler@cintras.com

4. No substitutions accepted.

B. Construction:

1. Bodies and Doors: Steel with a white-baked enamel finish.
2. Full-length piano hinge.
3. Adjustable shelves on locking aluminum mounting brackets.
4. Bullet-latch safety closure.
5. Signage: Lettering or graphics on cabinet.
6. Contents: Fully stocked.

2.3 SHARPS CONTAINER (SC)

A. Surface Mounted Cabinet: Covidien SharpStar Wall Mount In-Room Sharps Cabinet Model No. WRB2219120 manufactured by Global Industrial.

1. Size: 11-3/4 inches high by 13 inches wide by 5-1/2 inches deep.
2. Capacity: 5 gallons.
3. Color: Tan.
4. Lid: Counterbalance lid.

2.4 BLOOD BORNE PATHOGEN KIT (BBPK)

A. Surface-Mounted Plastic Kit: Model #250119.

1. Manufacturer: Cintas, www.cintas.com

a. Contact: Reese Dole, doler@cintras.com

2. No substitutions accepted.
3. Size: 8 inches by 10 inches.
4. Content: Blood borne pathogen kit

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls for suitable framing depth and blocking where recessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. In states where cabinets or kits need to be issued to Owner, verify that content is issued in the Owner's name.

3.2 PREPARATION

A. Prepare recesses for recessed emergency aid specialties as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. Install according to the manufacturer's instructions, and at locations and heights as shown on Drawings.

B. Install plumb, level, and rigidly anchored to substrate.

C. Orientational Signage: Coordinate signage pointing to cabinets with signage vendor.

3.4 STARTUP

A. Verify that the cabinets are equipped with scheduled content at Date of Substantial Completion.

3.5 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as emergency aid specialties are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of emergency aid specialties installation, clean interior and exterior surfaces as recommended by manufacturer.

C. Protect installed products from damage by later construction activities, until completion of project.

D. Field repair of damaged product finishes is prohibited. Replace products damaged by later construction activities.

3.6 MAINTENANCE

A. Service contract is not included in the Work of this Section.

END OF SECTION 104300

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for the following:

a. Portable fire extinguisher.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 104416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets.

1.2 PREINSTALLATION CONFERENCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fire-protection cabinets, including, but not limited to, the following:

a. Schedules and coordination requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing mounting method and relationships of box and trim to surrounding construction.

B. Shop Drawings: For fire-protection cabinets.

1. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

2.3 FIRE-PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Larsen’s Manufacturing; Architectural Series Model 2409-6R, or approved equal.

B. Cabinet Construction: Nonrated and fire-rated, at locations indicated on drawings.

1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch-thick cold-rolled steel sheet lined with minimum 5/8-inch-thick fire-barrier material. Provide factory-drilled mounting holes.

C. Cabinet Material: Cold-rolled steel sheet.

D. Recessed Cabinet:

1. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).

E. Cabinet Trim Material: Same material and finish as door.

F. Door Material: Steel sheet.

G. Door Style: Fully glazed panel with frame.

H. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide projecting door pull and friction latch.
2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

I. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.

J. Materials:

1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.

   a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
   b. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   c. Color: As selected by Architect from manufacturer's full range.

2. Transparent Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), with Finish 1 (smooth or polished).

2.4 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Miter corners and grind smooth.
3. Provide factory-drilled mounting holes.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Miter and weld perimeter door frames and grind smooth.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Finish fire-protection cabinets after assembly.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

C. Identification:

1. Apply vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 104413 "Fire Protection Cabinets."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.

b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Larsen's Manufacturing Company MP Series, or approved equal.
2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
3. Valves: Manufacturer's standard.
4. Handles and Levers: Manufacturer's standard.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

1. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 107316.13 - METAL PERGOLA

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal trellis.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include styles, material descriptions, construction details, fabrication details, dimensions of individual components and profiles, hardware, fittings, mounting accessories, features, and finishes for awnings.
2. Include rated capacities, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, system components, dimensions, attachments, and accessories.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

B. Qualification Data:

1. For Installer and fabricator.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal pergola to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Company specializing in performing Work of this section.

1.6 WARRANTY

A. Special Warranty: Manufacturer and fabricator agree to repair or replace components of metal pergola that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. Primary Structure: 10 years.
b. Screws and Louvers: Five years.
c. Accessories: Two years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Loads:

1. Wind Loads: As indicated on drawings.
2. Other Design Loads: As indicated on drawings.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METAL PERGOLA

A. Metal Pergola: Freestanding extruded 6063-T5 aluminum shade structure.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Pergolux S2, or approved equal.
2. Concealed Drainage: Water shall drain from louvers and be directed to ground level discharge via one or more designated support posts.
3. Finish: Factory powder coat.

a. Color: As selected by Architect from manufacturer's full range.

B. Fabrication: Preassemble metal pergola in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

1. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
2. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Fabricate slip-fit connections exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
3. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure pergola in place and to properly transfer loads.

2.3 ACCESSORY MATERIALS

A. Anchors, Fasteners, Fittings, Hardware, and Installation Accessories: Comply with performance requirements indicated and suitable for exposure conditions, supporting structure, anchoring substrates, and installation methods indicated.

1. Corrosion-resistant or noncorrodible units; weather-resistant, tamperproof, vandal- and theft-resistant, compatible, nonstaining materials.
2. Provide as required for metal pergola assembly, mounting, and secure attachment.
3. Number as needed to comply with performance requirements and to maintain uniform appearance; evenly spaced.
4. Where exposed to view, provide finish and color as selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for supporting members, blocking, inserts, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install metal pergola at locations and in position indicated, securely connected to supports, free of rack, and in proper relation to adjacent construction. Use mounting methods of types described and in compliance with Shop Drawings and fabricator's written instructions.

B. Slip fit frame connections accurately together to form hairline joints, and tighten to secure.

C. Anchoring to In-Place Construction: Use anchors, fasteners, fittings, hardware, and installation accessories where necessary for securing metal pergola to structural support and for properly transferring load to in-place construction.

3.3 CLEANING AND PROTECTION

A. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION 107316.13

SECTION 113013 - RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Refrigeration appliances.
2. Cleaning appliances.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranties: For manufacturers' special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

1.5 WARRANTY

A. Special Warranties: Manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.

1. Warranty Period, Compressor: Five years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain residential appliances from single source.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with applicable provisions in the DOJ's 2010 ADA Standards for Accessible Design and ICC A117.1.

2.3 REFRIGERATOR/FREEZERS

A. Refrigerator/Freezer: One-door refrigerator with freezer compartment inside and complying with AHAM HRF-1.

1. Basis-of-Design Product 8: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

2.4 CLEANING APPLIANCES

A. Stacked Washer/Dryer:

1. Basis-of-Design Product 10: As indicated on Sheet A12.0 Equipment Schedule or approved equal.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install appliances according to manufacturer's written instructions.

B. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and that rough openings are completely concealed.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
2. Operational Test: After installation, start units to confirm proper operation.

B. An appliance will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 113013

SECTION 114000.2 – FOOD SERVICE EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. The supply, delivery, and installation of all food service equipment as listed within the following specification and indicated on the related drawings.

1.2 SCOPE OF WORK

A. Except as otherwise herein stated, the work of this Section consists of the furnishing of all materials, labor, fabrication, transportation, equipment, and appliances required for the complete execution of all food service equipment as shown on the drawings, as specified, or both and as may reasonably be inferred as necessary to complete the work for Certificate of Occupancy and intended use by Owner. This shall include but not be limited to the following:

1. Stands and supports required for equipment, including backing plates.
2. Cutting of holes in equipment for pipes, drains, electric outlets, etc., indicated and those which are not indicated but which are required for this installation.
3. Installation of Owner furnished equipment as listed in the item specifications.

B. Where the word "Contractor" appears in this Section, this shall mean "Food Service Equipment Contractor."

C. Where the abbreviation "G.C." appears in this Section, this shall mean "General Contractor". Where the word "Consultant" appears in this Section, this shall mean "RealFood HSD" (617) 876-2100.

D. It shall be the Kitchen Equipment Contractor's responsibility to verify the quantities of the items listed herein with those shown on the drawings prior to submitting a bid. Any discrepancies detected by a bidder shall be called to the Consultant's attention for clarification. A written response to these inquiries will be made by the Consultant in writing to the Architect for distribution to the General Contractor and Bidders.

E. The Contractor shall adhere to all applicable Union Rules and Jurisdictional Trade Agreements. The Contractor shall work in harmony with other trades on this project to insure the prompt and successful completion of this project.

1.3 RELATED SECTIONS

A. Division 26 - Electrical Electric services, including wiring and final connections to the fixtures and equipment furnished under this Section, Owner furnished equipment, and.

B. Division 22 – Plumbing materials and installation including pipe, tube & fittings for potable water, chilled water, gas, compressed air, and wastewater for equipment furnished under this Section.

C. Division 23 – Mechanical: Water, gas steam and waste services to the fixtures and equipment, except as otherwise specified in individual items.

D. Section 233113: Except exposed ducts specified as part of equipment, all ventilation duct work including final connections to hoods and ventilators.

E. Section 096516: Flooring

F. Divisions 27 and 28 relating to audio video communication/notification devices including delivery door VIC, point-of-sale registers, and security systems.

1.4 RESPONSIBILITY

A. The work herein specified and/or shown on the Drawings shall be coordinated with the work of the other Contractors. It shall be the responsibility of the Contractor maintain regular communication with the G.C. and project team members to assure coordination and cooperation with all other trades performing work on this project.

B. Contractor for work of this Section shall examine and become familiar with drawings and specifications for architectural and mechanical work with reference to work in this Contract and shall be responsible for correct fitting of his work in connection with such related work. He shall become familiar with all job conditions, building measurements, and other conditions in order to coordinate the planning, design, delivery, storage and installation of his work, all with proper consideration of the project progress schedule.

C. The Contractor will be held responsible for verifying the electric current characteristics. If any of the equipment to be supplied does not coincide with that which is indicated on the Schedule or the Roughing Drawings, it will be the supplier's responsibility to call the discrepancy to the attention of the Consultation prior to submitting the questionable item.

D. It shall be this Contractor's responsibility to visit the site and coordinate with other trades to preclude cutting and patching and in the event of units of equipment too large to pass through planned openings, arrange for access to the required areas ahead of time not to delay delivery schedule.

E. In addition to the requirements set forth in the Project Specifications, the Contractor shall be completely responsible for the fulfillment of all the requirements pertaining to the fabrication, assembly and installation of all the items of this Section, including those of his subcontractors.

F. Provide all appurtenances which may not be specifically mentioned in the specifications or shown on drawings, but which are required for the proper function and installation of the equipment.

1.5 QUALIFICATIONS

A. Contractor shall submit satisfactory evidence that they are now and have been for the past five (5) years, engaged in the food service equipment industry, installing projects of the type and size herein specified as their principal line of work. Contractor must submit to the Consultant the name of his fabricator for approval, prior to bidding. Contractor's fabricator must show evidence he can meet the requirements concerning qualifications. Contractor's fabricator submitted and approved must be sub-contractor used.

B. Contractor shall also submit evidence showing that he has executed contracts of a size comparable to the work herein specified and that he has the experience and financial resources to enable him to execute the work in a satisfactory manner and to deliver the required items of equipment so as not to delay the orderly progress of the work.

C. If, because of trade union rules and jurisdictional trade agreements or their conditions, any work specified to be performed under the Contract must be done by a particular trade, the Contractor shall sublet such work to those who may or can do such work or make other arrangements at his own expense and submit name of manufacturer or sub-contractor for approval prior to bidding.

D. The Contractor shall have open accounts with all major food service equipment manufacturers and shall indicate in writing that he or she is capable of being bonded up to the actual amount of the food service equipment contract.

1.6 QUALITY ASSURANCE

A. Requirements of regulatory agencies:

1. In addition to complying with other legal requirements, comply with:

    a. National Sanitation Foundation Regulations (NSF)
    b. AGA: Approved gas-fired equipment.
    c. UL: Approval and listing for equipment and electrical devices.
    d. Reference specifications and standards:
    e. NEMA: LP-3, Plastic Laminates.
    f. ASTM: Designations specified.
    g. ANSI: Z21.20, Automatic Gas Ignition Systems & Components.

B. Substitutions and Product Options:

1. Procedures: In accordance with the Bidding and Contract Requirements Section of the General Specifications of this project.
2. Throughout these specifications, manufacturers and model numbers have been selected by the Owner and the Consultant. These have been picked and agreed to for the purpose of establishing a standard of quality and performance. Therefore, this Contractor will not assume the option of substituting any materials or appliances for that specified.
3. If a bidder elects to take any exceptions to the equipment specified, he must request the Consultant's approval in writing to substitute any specified item prior to submitting his bid. The burden to prove equality to that which is specified will be the bidder's responsibility. In his request for such approval to deviate from contract documents, he will submit the

proposed substitutes stating dealer net cost difference involved with supporting data. Such supporting data shall include basic specifications of the item(s) and the specifications, characteristics and other information concerning the proposed substitution demonstrating its equality to the specified item(s) and the effect of the substitution including serviceability and warranty.

4. This Contractor will bear all responsibility for adjustments to space, utility services and construction differences incurred by substituted item(s). He will pay all additional costs that may occur due to requirements of accepted substitutions if approved, including but not limited to engineering, design, and construction costs.
5. Note: All bids shall be submitted to the General Contractor on an MS Word Excel spreadsheet and shall include the following columns: Item Number, Qty, Description, Unit Cost, and extended cost. Each equipment item shall be listed on a separate row by number. Unit equipment cost shall include installation, warranties, and freight.

1.7 SUBMITTALS

A. Procedure: Submit in accordance with the Bidding and Contract Requirements Section of the General Specifications of this project.

B. Contract documents of the Food Service Consultant were prepared along with the Architectural and Engineering drawings, not after. The KEC should be aware that there may be inconsistencies and minor discrepancies between these sets of documents.

C. Contractor prepares their submittal drawings; they shall not copy the Consultant's drawings. The KEC submittal drawings shall reflect the manufacturers, models, and utility requirements of the equipment being provided by the KEC. The KEC submittal drawings shall be prepared by using dimensioned architectural and structural plans, increasing to 1/4" scale if required.

D. Rough-in drawings.

E. The KEC shall submit ¼” scale .pdf rough-in plan drawings for approval. Drawings shall be dimensioned, showing ventilation ducts, floor and wall sleeves, plumbing, gas, steam, and electrical lines, including those items purchased or supplied by the Owner. Elevations shall be submitted at 3/8” or 1/2” scale and sections of special work shall be submitted at 1” or 1 ½” scale.

F. The following shall each be drawn on separate sheets and/or plans; Plumbing; Electrical, and Ventilation. In addition, the KEC shall provide ¼” dimensioned plans locating slab recesses, wall blocking, and chases for Refrigeration and beverage lines.

G. Utilities shall be stubbed out of walls wherever possible.

H. Kitchen Equipment Contractor or their authorized representative(s) shall field verify mechanical, electrical, and ventilating rough-in and sleeve locations before floor slabs are poured.

I. Shop drawings:

1. Submit detail drawings at 3/4 inch and 1-1/2-inch scale.
2. Indicate dimensions, details or construction, installation, relation to adjoining and related work where cutting or close fitting is required.

3. Verify at job site, all dimensions, mechanical, electrical and ventilation rough-in, and sleeve locations before fabrication.
4. Indicate all reinforcements, anchorages and other work required by other trades for complete installation of all items.
5. Include on shop drawings all items furnished by the Owner. Owner will provide Contractor with product data and other information required for detailing.
6. Shop drawings submitted for custom fabricated stainless steel items must show all items in plan, elevation, section, and isometric views.

J. Product data: Manufacturer's detailed literature, catalog cuts, and specifications:

1. Submit for each manufactured item. Include rough-in and service information and details.

K. Maintenance data and operating instructions:

1. Provide the following:

a. System description.
b. Wiring diagrams.
c. Operating sequence.
d. Manufacturer's data.
e. Preventative maintenance.
f. Trouble shooting.
g. Warranties.
h. Directory.
i. Valve directory with tag schedule showing location of each valve, type, number, and manufacturer.

2. Upon completion of project, the KEC shall compile required operating maintenance data on all food service equipment items into a single .pdf file indexed by item number. Provide (1) printed hard copy incorporated in hardback, three-ring binders with dividers for each item number. These .pdf files shall Include a complete list of service agencies for all equipment including phone numbers.

1.8 WARRANTY

A. Guarantee all equipment furnished under this Section for a period of one year or more in conjunction with a longer manufacturer warranty offering. covering defective materials, design and workmanship. Upon receipt of notice of failure of any part of the warranted equipment during the warranty period, the affected part or parts shall be replaced promptly and at the expense of the food service equipment installer.

B. Until the time replacement equipment is installed, the Owner shall have full use of the defective equipment.

C. Warranty shall include installation, start-up and one-year free service for all self-contained Refrigeration equipment with evidence of manufacturer's one year Warranty on the entire cabinet and additional four-year Warranty on sealed compressor motor assembly except for labor.

D. It will be the sole responsibility of the KEC in working with the manufacturer to ensure that ALL warranties are not to start before the First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 MATERIAL

A. Stainless steel: ASTM A240, U.S. Standard gauges, 18-8 type 302 or 304, not over 0.12% maximum carbon. Provide No. 4 finish unless otherwise specified.

B. Galvanized steel: Arco, gauges as specified or indicated on Drawings.

C. Sink wastes: All custom fabricated and die-drawn sinks: Rotary type waste outlet with one-piece connected overflow assembly and stainless steel removable basket strainer manufactured by Component Hardware Group as “Drain Master” Model DSS-8000.

D. Legs: 1-5/8-inch diameter 16-gauge stainless steel tubular legs with bullet type feet, Model A10-0881 as manufactured by Component Hardware Group, unless specified or detailed otherwise.

E. Hardware: Except where specified otherwise, all hardware shall be solid material, and where exposed, chrome plated or stainless steel.

1. Provide locking type hardware.
2. Identify hardware with manufacturer's name and number so that broken or worn parts may be ordered and replaced.
3. Unless specified otherwise, provide Kason No. 171C magnetic latches with No. 218 self-closing hinges for undercounter refrigerator doors.
4. Unless otherwise specified, provide stainless steel recessed flush pulls, Klein Hardware, Model #12000, and Klein Model #242, solid brass, satin finish door catches for refrigerated drawers, side sliding doors, access panels and hinged doors.

F. Locks and keys: Equip all doors and drawers on all equipment with stainless steel hasps for padlocks.

G. Faucets and Pre-Rinse Spray Units: “Encore” as manufactured by Component Hardware Group. Model numbers as shown on Drawings.

1. Approved Alternate Mfgrs: T&S, Chicago

H. Drawers: Model S90-0020 manufactured by Component Hardware Group.

I. Sound Deadening Material: Q75-2500 “Multiflec Sound Deadener” as manufactured by Component Hardware Group. Color Grey.

J. Inset type sinks: 16 gauge or heavier polished stainless steel (installed in tops as an integral part of the fixture).

K. Casters: Size and type specified, double ball bearing, rubber-tired, heavy duty, 1 inch tread width, cadmium plated, as manufactured by Jarvis and Jarvis, Inc., except that the manufacturer's standard casters will be accepted on standard items.

L. Plumbing Products: All plumbing products shall utilize "lead free" castings and comply with NSF Standard 61, Section 9 (11 micrograms or less of lead when normalized to one liter).

M. Miscellaneous materials: Provide as specified with specific equipment item.

2.2 FABRICATION

A. All custom fabricated equipment shall be provided by approved fabricator. The fabricator must be NSF Certified, and if any custom fabricated equipment within the bid contains an electrical load center, the fabricator must be qualified to produce a UL listed assembly.

B. Approved fabricators:

1. FSF Manufacturing, Oviedo, FL 407-971-8280
2. BSI MFG - Denver CO
3. Duke MFG

    a. All other fabricators must be approved prior to bidding.

C. Submittal Drawings:

1. Drawings indicate general arrangement of the piping and location of equipment. Should it be necessary to deviate from the arrangement indicated in order to meet structural conditions, such deviations, as approved, shall be made without additional expense to the Owner.
2. Exact locations, distances, and levels shall be governed by the building conditions and shall be verified on-site by an authorized representative of the Fabricator.
3. Submittal drawings shall be computer generated, fully dimensioned, indicate all material types, finishes, and gauges, and shall show all pieces of fabrication in plan, elevation, section, and isometric views. Drawings shall be submitted in .pdf format.

D. General:

1. Provide all fabrication in accord with NSF Standards.
2. Only type 304 stainless steel shall be used.
3. Provide fully welded construction.

E. Welding:

1. Make all shop and field welds continuous and hidden or ground smooth.
2. Polish exposed welds in stainless steel to original finish after grinding, with no visible welds, line or buckles.
3. Grind galvanized steel so no visible welds, lines or buckles show, and touch-up with galvanizing stick, where galvanizing has been removed.

F. Manufacturer's instructions: Follow manufacturer's directions in all cases where the manufacturer of items used in this work furnish directions or prints covering points not indicated or specified.

G. Metal tops:

1. Fabricate all tops from 14-gauge No. 4 finish stainless steel unless specified otherwise. Provide one-piece welded construction reinforced on the underside with 14-gauge stainless steel channels. Worktable and sink undershelves shall be 16-gauge s/s.
2. Provide cross braces not more than 30-inch O.C. Coat underside of all tops with a minimum of 1/8 inch thick approved hard-drying, sound-deadening mastic material dried smoothly without dirt-catching crevices.

H. Enclosed cabinet type bases:

1. Made of formed sheets reinforced to create a rigid structure. All unexposed sections, upright partitions and back shall be 18-gauge galvanized steel or heavier, except as specified otherwise.
2. Exposed body facings, partitions, stiles, and aprons shall be 18-gauge stainless steel, No. 4 finish, unless otherwise specified.
3. Shop weld all seams and joints where possible. Ground welds smooth and polish welds to match original finish. Faces to have knuckle seams between walls, skirts, and shelves.
4. Finish ends of all fixtures, splash backs, shelves, etc., flush to walls or adjoining fixtures.
5. Provide access holes in panels in the equipment to allow plumbing and electrical trades to make their respective connections.

I. Coved corners:

1. Provide all dish tables, drain tables, work tops, splash backs and turned-up edges with radius bends on all inside horizontal and vertical corners, and coves at intersections.
2. Provide all shelves, under shelves, elevated shelves, port shelves, etc., with turned-up edges and radius bends on all inside horizontal corners.
3. Unless specified otherwise in individual items, provide rounded and coved corners or radius ends of 3/4-inch radius or larger.

J. Fabricate equipment legs and cross rails from 1-5/8-inch diameter 16-gauge stainless steel tubing unless otherwise noted. Grind smooth and polish all welds at cross-rails. Fit bottom of each leg at floor with a sanitary stainless steel bullet type foot with not less than 2-inch adjustment. Fasten legs to equipment as follows:

1. To sinks by means of cylinder gussets: Provide stainless steel gussets reinforced with bushing and set screw for securing legs. (United Show Case No. LC-158).
2. To metal top tables and dish tables: Provide cylinder gussets or equivalent, welded to 14 gauge or heavier channel. Weld bracing to underside to tops.
3. Closed gussets shall be a minimum 3-inch diameter on top continuously welded to frame members of sink bottoms.

K. Sinks:

1. Provide fabricated sink compartments with fully coved vertical and horizontal interior corners. All coves 3/4" radius.

2. Where one or more sink compartments are adjacent, provide double thickness partitions, continuously welded at top. Fronts of multiple compartment sinks to have applied skirt on exterior.
3. Crease bottoms of each sink compartment to insure complete drainage to waste opening.
4. Install inset type sinks in tops as an integral part of the fixture.

L. Drawers:

1. Model S90-0020 manufactured by Component Hardware Group or custom fab to following standards:
2. Fabricated die stamped 18-gauge stainless steel with stainless steel fronts. Fabricate support slides so that drawers may be pulled out a minimum of two-thirds or its length and still support heavy loads without deflection.
3. Fabricate to allow easy removal without the use of tools. Provide with built-in flush type pulls. All drawers mounted on open tables shall have enclosure on sides and rear and shall be self-closing.
4. Mount drawers in refrigerated sections on large ball bearings surface in flat tracks.
5. Wheels and bearings shall be corrosion resistant, long wearing material, grease packed before assembly.
6. Provide a means of locking all drawers. This may include an integral hasp for use with an Owner supplied lock.

M. Doors:

1. All doors shall be double pan type, outer pans cased, with welded corners.
2. Sliding doors: Removable double pan type, reinforced and stiffened with closed hat sections, and mounted on ball bearing quiet rollers in overhead tracks.
3. Hinged doors: Flush type mounted on heavy-duty stainless steel lift-off flag hinges. Fill inside core of doors with sound deadening material. Provide built-in flush type pulls as detailed.

N. Shelves:

1. Overhead shelves: Constructed of #16-gauge stainless steel not less than 12" wide, unless otherwise specified. The shelves shall be polished on all surfaces (top and bottom). Each shelf shall be made in 1 ea piece or butt welded, ground and polished smooth. Shelves shall be made as shown, welded, ground, and polished. Where shelves adjoin walls, gauge stainless steel wall brackets, triangular shaped, spaced not more than 48 inches on center, welded to stainless steel 1-1/4" diameter, #16-gauge stanchions mounted through table backsplash unless otherwise specified for particular item.
2. Under shelves: At open tables constructed of #16-gauge polished stainless steel, having edges turned down 1-1/2" and under 3/4" except at walls turned up 2"; with all corners welded, ground and polished; where required shelves suitable reinforced with stainless steel channels running the full length. Shelves connected to legs by means of notching and continuous welding. All cabinet bottoms will be 18-gauge stainless steel reinforced as required and shown on the contract drawing, completely integrally flush-welded to cabinet face. Provide ferruled openings in bottom shelves top entry of service where required.

2.3 UNDERCOUNTER REFRIGERATORS (See Item Specification)

2.4 HEATING EQUIPMENT

A. Provide gas, electric or steam heating equipment or thermostat control for such equipment, and of materials, sizes or ratings specified within the equipment items or details.

B. All such equipment shall be of nature and so installed as to be readily cleanable or made easily removable for cleaning.

C. Electrical appliances or heating element circuits of 120 volts shall not exceed 1650 watts.

2.5 GAS-FIRED EQUIPMENT (Not Used)

2.6 SWITCHES AND CONTROLS

A. Provide on each motor driven appliance or electrical heating unit a suitable control switch or starter of proper type in accord with UL requirements. All other switches and controls, including line switches, safety cut-outs, control panels, fuse boxes, other controls, fittings, and connections will be furnished and installed by the electrical trade except where specific instances are specified otherwise.

B. Provide all internal wiring for fabricated equipment items, including all devices, wiring controls, switches, electrical boxes, receptacles, stainless steel face plates, conduit, and wiring, etc., built into or forming an integral part of these items, in factory or at the job site, with all items completed to a junction box for final connection to the building services by the electrical trade.

C. Fixture internal wiring shall conform to UL guidelines.

D. Provide standard 3-prong plug to fit "U" slot grounding type receptacles, similar to Hubbell No. 5262, for all equipment items noted as powered by plug connection into 110-120 volts, single phase A.C. Provide suitable length 3-wire cord for all such equipment.

2.7 UTILITY CONNECTIONS

A. Provide equipment complete with connection terminals as standardized by equipment manufacturers except where specified otherwise, for other trades to make plumbing, gas, steam, electrical, ventilation and Refrigeration connections.

B. Provide equipment including refrigerated drawer section and ice bins, and all indirect wastes or other special applications, with 1-inch minimum copper drain tubing of sufficient length to extend to floor sinks. Wrap chilled or cold water drain tubing with 1/4-inch-thick foamed plastic insulation to prevent condensation.

C. Water filtration is to be handled locally based on a water test performed by the KEC providing the equipment. Based on varying water quality the KEC is to provide filtration complements that meet or exceed manufacturer requirements.

2.8 TRIMMING AND SEALING EQUIPMENT

A. Seal spaces between all units at walls, ceilings, floors and adjoining non-portable units with enclosed bodies against entrance of food particles or vermin by means of s/s trim, strips, welding, soldering or commercial joint materials as suited to the nature of the equipment and adjacent materials.

B. Close ends of all hollow sections.

C. Fixtures resting on concrete bases shall be set into sealant bed to eliminate crevices between fixture and base and caulked after installation has been completed.

2.9 EXHAUST VENTILATORS (See Item Specification)

A. Streivor is to be the sole Hood manufacturer - No Alternate Manufacturers to be used.

B. Kitchen Equipment Contractor (K.E.C.) must provide factory authorized start-up supervision and inspection with written confirmation of same issued to Architect within 48 hours of start-up. Confirmation letter should include names of Owner's representative(s), Contractor's representative(s), and factory service representative present at time of start-up. Units must comply with all applicable codes and be of type 304 s/s construction.

2.10 WALK IN REFRIGERATORS (See Item Specification)

A. Acceptable Manufacturers: American Panel, Norlake, Bally, Arctic

1. All other Manufacturers to be approved prior to bidding.

B. See item specification for detailed requirements.

C. If concrete and/or quarry tiles is to be installed after the walk-in box is erected, all walk-in doors must remain open. Curing concrete can generate hydrogen gas that may cause discoloration of metal wall and ceiling panels. Protect wall panels from concrete, grout, or chemical splatter with polyethylene sheets taped to walls.

D. Installation guidelines must accompany all panel structures in the form of complete panel assembly and erection instructions. Accepted construction procedure and special techniques must be described. All necessary working drawings with dimensional detail shall be supplied to illustrate exact location of specific panels. Drawings must clearly indicate inside and outside diagonal dimensions to facilitate “square” layout of all regular shaped structures.

E. All plastic protective sheeting must be removed from panels before installation.

F. Parts and hardware not manufactured by walk-in manufacturer (door hardware, electric components and various optional accessories listed below) shall be guaranteed against defects in material and workmanship under normal use and service for a period of three (3) years.

G. The manufacturer of the walk-in assembly will replace any panel or part they accept as defective in material and workmanship when those panels are installed properly and used in normal service for a period of ten (10) years.

2.11 REFRIGERANT SYSTEMS (See Item Specification)

A. General Note: Center mount "spacemizer" evaporator coils may not be used in any freezer compartment. KEC and manufacturer to confirm HP requirements for all units submitted. Design submitted by factory shop drawings shall reflect, field dimensions, building temp/humidity, use, and configuration of compartments.

2.12 ITEM SPECIFICATION AND SCHEDULE OF EQUIPMENT

PART 3 - Note: All items listed on the contract drawings under the heading "Foodservice Equipment Schedule" shall be furnished by the Kitchen Equipment Contractor in accordance with the Master project specifications, food service equipment plans, and the following detailed item specifications.

ITEM A1 - EXHAUST HOOD (1 REQ'D)
Streivor Model System
Refer to Factory Shop Drawings for Final Details

ITEM A1.1 - FIRE SUPPRESSION (1 REQ'D)
Streivor - PyroChem
Refer to Factory Shop Drawings for Final Details

ITEM A1.2 - HMI CONTROLS
Streivor - Hood Control Panel
Refer to Factory Shop Drawings for Final Details
Alternate – Melink Intellihood

ITEM A2 - MULTI-FUNCTION COOKER, ELECTRIC (1 REQ'D)
RATIONAL Model IVARIO PRO XL P 3PH 440/480V (LMX200DE) Dimensions: 23.88(h) x 53.75(w) x 35.25(d) (WW9EPRA.0013567) iVario Pro XL, Pressure Version, Multifunctional Cooking Center, (1) 40 gallon pan, pressure cooking option, integrated iVarioBoost energy management system, 85° to 480°F temperature range, iZoneControl with up to (4) individually controlled heating zones, iCookingSuite Intelligent cooking system, 6-point sensor core temperature probe, AutoLift (baskets and arm required for use), portioned water dispenser, retractable hand shower, ethernet interface, wifi enabled, includes stand with plastic feet, 440/480v/60/3-ph, 44.0 kW, CE, ETL, NSF, IPX5

1 ea Pressure XL
1 ea 2 years parts and labor warranty, standard

1 ea Model CAP Chef Assistance Program, a RATIONAL certified Chef conducts 4 hours/location specialized application training with personnel, no charge
1 ea Model 8730.1565US Installation Kit, includes parts for: water connection, electric hardwiring, & copper drain line, for iVario size 2-S (208/240v), L (208/240v & 440/480v) and XL (440/480v) (NET)
1 ea Model 60.70.107 VarioMobil® Cart, for transporting 20" x 25" or 12" x 20" hotel pans, height adjustable, for size L and XL
1 ea Model 60.73.920 Cleaning Kit, includes: 2.65 gal. grill cleaner, (1) cleaning arm, (2) rough pads, (2) soft pads, & (1) cleaning scrub
1 ea Model 60.74.908 Strainer, for size XL
1 ea Model 60.75.129 AutoLift arm, for size XL

ITEM A2.1 -FLOOR TROUGH (1 REQ'D)
Advance Tabco Model FFTG-2424 Dimensions: 4(h) x 24(w) x 24(d) Floor Trough, 24"W x 24"D x 4" deep, with fiberglass grating, stainless steel removable strainer basket, 4" O.D. waste pipe 3"L, pitched towards waste, NSF

ITEM A2.2 - WATER FILTER (1 REQ'D)
Rational Model 1900.1154US
Water Filtration Single Cartridge System, for any iVario, single Combi model, or XS or half-size Combi-Duos, includes: (1) single head with pressure gauge, R95-CL filter & filter installation kit, include replacement cartrtidge

ITEM A4 - COMBI OVEN, ELECTRIC (2 REQ'D)
RATIONAL Model ICP 6-FULL E 480V 3 PH (LM100CE) Dimensions: 29.6(h) x 42.25(w) x 38.4(d) (CC1ERRA.0000219 - E - 480V) iCombi Pro® 6-Full Size Combi Oven, electric, (6) 18" x 26" sheet pan or (12) 12" x 20" steam pan or (6) 2/1 GN pan capacity, (3) stainless steel grids included, Intelligent cooking system with (4) assistants; iDensityControl, iCookingSuite, iProductionManager, & iCareSystem, (6) operating modes, (5) cooking methods, (3) manual operating modes, 85° to 572°F temperature range, quick clean, care control, eco mode, 6-point core temperature probe, retractable hand shower, Ethernet interface, Wi-Fi enabled, includes (1) bucket of Active Green Cleaner & (1) bucket of Care Tabs, 480v/60/3-ph, 22.4 kW, IPX5, UL, cULus, NSF, ENERGY STAR-®

2 ea 2 years parts and labor, 5 years steam generator warranty
2 ea Model CAP Chef Assistance Program, a RATIONAL certified Chef conducts 4 hours/location specialized application training with personnel, no charge
2 ea Model 9999.2201 RCI RATIONAL Certified Installation, new certified installation for each individual electric table-top iCombi on a stand or counter (Do not use for Combi-Duo, Travel not included. See attached installation flyer for details)
2 ea Model 8720.1552US Installation Kit, for electric iCombi/SCC/CMP 61 (208/60/3 & 240/60/3); electric iCombi/SCC/CMP 101 (440/60/3 & 480/60/3); electric iCombi/SCC/CMP 62 (440/60/3 & 480/60/3)
2 ea Model 56.01.535 Cleaner tablet Active Green, for all iCombi Pro/Classic, 150 pieces/bucket

2 ea Model 56.00.562 Care Tablets, bucket of 150 packets for all SelfCooking Center® units from 10/2008, with CareControl - Serial SG, SH or SI series (minimum order quantity: 2pcs, unless ordered with a unit)
2 ea Model 56.00.598 Rational Defoamer Tabs, for all iCombi Pro, iCombi Classic, SelfCooking Center, and CombiMaster Plus (from 05/2017 onward) units, to reduce foaming in water types subject to severe foam build-up during cleaning, 120 tablets per bucket (special order item) (minimum order quantity: 2pcs, unless ordered with an iCombi unit)
2 ea Door hinged on left
2 kt Model 60.76.710 Stacking Kit for Combi-Duo, iCombi 6-full size (electric) on iCombi 6- or 10-full size (electric), left-side hinge (MarineLine)
2 ea Model 60.76.845 Leveling kit, mountable for marine version & seismic applications, height adjustable by ¾", for placing on unlevel surfaces, stainless steel construction, for iCombi 6- and 10-full size
2 ea Model 60.76.316 Sous-Vide Core Temperature Probe, USB connection, for 6, 10, and 20 Full and Half size models
2 ea Model 60.75.768 Heat Shield, for right side panel, type 6-full size Pro/Classic
2 ea Model 20.02.551P Door Gasket, for iCombi 6-full size Classic/Pro
2 ea Model 40.05.424P Air Inlet Filter, for iCombi 6-half, 6-full, 10-half, or 10-full size Classic/Pro

ITEM A4.1 - WATER FILTER, DOUBLE (1 REQ'D)
Rational Model 1900.1150US
Water Filtration Double Cartridge System, for full-size Combi-Duos or if used for more than (2) units, includes: (1) double head with pressure gauge, (2) R95-CL filter & (1) filter installation kit (for each additional unit add (1) additional head & additional cartridge. Maximum (4) cartridges) include replacement cartrtidge

ITEM A6 - INDUCTION RANGE, COUNTERTOP (1 REQ'D)
CookTek Model 641600 Dimensions: 17.2(h) x 36(w) x 30.4(d)
(MC21006-200) Commercial Induction Range, countertop or worktable mounted, (6) 3500 watt burners, glass-ceramic top, control knob, microprocessor with (10) power cook settings & auto-shut-off, automatic pan detection, LED display, integral cooling fan & grease filter, stainless steel housing, 208v/50/60/3-ph, 21.0kW, 58.3 amps, cETLus, NSF, CE, Made in USA

1 ea One-year limited parts and labor warranty in US/Canada only
Approved Alternate - Garland Heavy Duty

ITEM A6.1 - EQUIPMENT STAND (1 REQ'D)
Advance Tabco Model ES-304, 36(w) x 30.4(d) x 20" Tall, Equipment Stand, 48"W x 30"D x 25"H (overall), 24" working height, 14 gauge 304 stainless steel top with 1"H up-turn on sides & rear, 18 gauge adjustable stainless steel undershelf, stainless steel legs with adjustable stainless steel bullet feet, NSF
Increase Depth to 36"
Reduct Width to 42"
20" Working Height
4" locking casters set

ITEM A6.2 - SHELVING, WALL MOUNTED (1 REQ'D)
New Age Model 97285 Dimensions: 36(w) x 20(d)
Shelf, wall-mounted, inverted, 36"W x 20"D, 12-gauge aluminum construction, NSF, Made in USA

1 ea Lifetime warranty against rust & corrosion, 5-year workmanship and material defects warranty, standard

ITEM A6.3 - FAUCET, KETTLE / POT FILLER (1 REQ'D)
T&S Brass Model B-0592-CR
Pot & Kettle Filler Faucet, wall mount, single control, 18" double-jointed nozzle, heat-resistant 4-arm handle, ceramic cartridge, insulated on/off control, low lead, 1/2" NPT, NSF

ITEM A6.4 - WORK TABLE, STAINLESS STEEL TOP (1 REQ'D)
Advance Tabco Model TFMSU-183 Dimensions: 37(h) x 18(w) x 36(d)
Equipment Filler Table, 18"W x 36"D, 16-gauge 304 stainless steel top with 1-1/2"H rear upturn, 16-gauge 304 stainless steel undershelf, stainless steel legs & adjustable bullet feet, NSF (filler table needs to be placed between (2) other tables for stability)

ITEM A7 - GRIDDLE, ELECTRIC, COUNTERTOP (1 REQ'D)
AccuTemp Model EGF4803A3650-T1 Dimensions: 40.12(h) x 36.25(w) x 34.7(d)
Accu-Steam™ Griddle, electric, 36" x 30" griddle area, 7 ga. 304 stainless steel cooking surface, digital thermostat & controls, 4" grease trough, 14 ga. stainless steel cabinet, 480v/60/3-ph, 19kW, 23 amps, cord with NEMA L16-30P, cULus, UL EPH, ENERGY STAR™, Made in USA

1 ea 1-year parts & labor warranty, standard
1 ea Lifetime service and support guarantee

ITEM A7.1 - CONVECTION OVEN, ELECTRIC (1 REQ'D)
Southbend Model TVES/10SC Dimensions: 26.2(h) x 36.1(w) x 36.5(d)
TruVection Convection Oven, electric, low-profile, single deck, electronic nition, 150-550°F solid state thermostatic controls, 60-minute mechanical cook timer, oven interior lht, cool down fan, includes (3) racks, porcelain oven interior, stainless steel door handle, front, sides, top & 6" legs, 1/2 HP, 7.5kW, CSA, NSF (Note: Qualifies for Southbend's Service First™ Program, see Service First document for details)

1 ea Domestic Shipping, inside of North America
1 ea Standard (1) year limited parts and labor warranty when purchased as a stand-alone base or stacked model unit (reference warranty document for details)
1 ea 480v/60/3-ph, 9.0amps
1 ea Stainless steel interior, per deck
1 ea 4" Low Profile Casters

ITEM A8 - FRYER BATTERY, ELECTRIC (1 REQ'D)

Pitco Frialator Model SE18RS-1FD Dimensions: 49.75(h) x 19.63(w) x 34.38(d)
Solstice™ Prepackaged Fryer System with Solstice™ Solo Filter System, Hh Power, electric, (1) 70-90 lb. oil capacity full tank, solid state controls, boil out, drain valve interlock, melt cycle, stainless steel tank, front & sides, under-fryer drawer filtration, 22.0kW (-F), UL, NSF, CE

1 ea NOTE: Power supply for basket lifts and filter motor is hard wired at the factory for 208v, 240v models
1 ea 1-year parts and labor warranty from the date of installation up to a maximum of 15 months from the date of manufacture (with appropriate documentation), standard
1 ea 480v/60/3-ph, 27.0 amps, 22 kW, DIRECT
1 ea Digtal Controller
1 ea Model P6072184 Basket, (2) oblong/twin size, 17-1/4" x 8-1/2" x 5-3/4" deep, front handle, regular mesh (shipped std for models 65C+, SG18, SE18, SSH75, fryer batteries shipped with (2) per fryer
1 ea Model D9109105 Fat Vat, safe oil transport system holds 40 lb. (5.3 gallons)
1 ea Casters, 10", rigid non-locking and locking, for (1) SE/SG fryer, with SoloFilter

ITEM A9 - FRYER DUMP STATION (1 REQ'D)
Pitco Frialator Model PCF-14 Dimensions: 45.19(h) x 15.63(w) x 34.81(d)
Crisp 'N Hold™ Crispy Food Station, floor model, 2 sections, capacity 837 cu. in., circulated air heating, removable product tray, grease filter, stainless steel construction, UL, ETL

1 ea 1-year parts and labor warranty from the date of installation up to a maximum of 15 months from the date of manufacture (with appropriate documentation), standard
1 ea 120v/60/1-ph, 15.1 amps, 1820 watts
1 ea Stainless steel back
1 st Model B3901504 Casters, 9" adjustable swivel (set of 4) non-lock rear & lock front casters, solstice supreme, SG, SE, VF and flat bottom fryers, pasta cookers, rethermalizers, BNB

ITEM A10 - WORK TABLE, STAINLESS STEEL TOP (1 REQ'D)
Advance Tabco Model TMS-369 Dimensions: 35.5(h) x 108(w) x 36(d)
Worktable, 108"W x 36"D, 16-gauge 304 stainless steel top, stainless steel legs with side & rear crossrails, adjustable stainless steel bullet feet, NSF

1 ea Model TA-22 Square edge table
1 ea Model TA-62F Junction Box (empty) below tabletop, 1-gang size, stainless steel face plate (wiring & utility chases or provisions not included
1 st Model TA-25A Casters, 5", swivel, with rubber wheels, set of (6) (2 with brakes)
Approved Alternate – Custom Fabrication

ITEM A11 - POT RACK (1 REQ'D)
Advance Tabco Model SC-108 Dimensions: 12(h) x 108(w) x 22(d)
Pot Rack, ceiling hung, triple bar design, 108"W x 22"D, constructed of 1/4" x 2" stainless steel, includes: (18) plated double pot hooks & 24" plated hanging chains
Approved Alternate – Custom Fabrication

ITEM A12 - UNDERCOUNTER REFRIGERATOR(1 REQ'D)
True Mfg. - Model TUC-93D-4-HC Dimensions: 29.75(h) x 93.25(w) x 32.25(d)

Deep Undercounter Refrerator, 33 - 38°F, side mounted self-contained refreration, (1) stainless steel door, (2) PVC coated adjustable wire shelves, (4) drawers accommodates (2) 12"x 20"x8" pans (NOT included), stainless steel top & sides, aluminum interior with stainless steel floor, R290 Hydrocarbon REFRIGERANT, 1/3 HP, 115v/60/1-ph, 4.5 amps, NEMA 5-15P, cULus, UL EPH Classified, Made in USA

1 ea Self-contained Refrigerationstandard
1 ea Warranty - 7-year compressor, please visit www.Truemfg.com for specifics
1 ea Warranty - 3-year parts and labor, please visit www.Truemfg.com for specifics
1 st Castors, 2-1/2", set of 6

ITEM A14 - WORK TABLE, STAINLESS STEEL TOP (1 REQ'D)
Advance Tabco Model MS-366 Dimensions: 35.5(h) x 72(w) x 36(d)
Work Table, 72"W x 36"D, 16 gauge 304 stainless steel top, 18 gauge stainless steel adjustable undershelf, stainless steel legs & adjustable bullet feet, NSF
Approved Alternate – Custom Fabrication

ITEM A15 - PLASTIC SHELVING UNIT (1 REQ'D)
Metro Model MQ-243676G-MP-4
MetroMax® Q Starter Shelving Unit, 36"W x 24"D x 74"H, rust proof, 1000 lb. capacity per shelf, 2000 lb. capacity per unit, (5) open grid polymer shelves with reinforced type 304 stainless steel corners and removable polymer shelf mats, bag of (4) wedge connectors included with each shelf, (4) polymer posts, Microban antimicrobial product protection, KD, NSF

ITEM A15.1 - MIXING BOWL, METAL (1 REQ'D)
Vollrath Model 79818

ITEM A99 - S/S WALL PANELING (1 REQ'D)
Custom Fabrication - Stainless Steel Wall Paneling behind Hotline
Paneling To Cover Entire Hood Wall - All Dimensions per plan

ITEM C1 - HAND SINK (4 REQ'D)
Advance Tabco Model 7-PS-62 Dimensions: 26.5(h) x 17.25(w) x 15.25(d)
Hand Sink, wall mounted, 14" wide x 10" front-to-back x 5" deep bowl, Deep Drawn™ sink bowl, 20-gauge 304 stainless steel, heavy duty splash mounted gooseneck faucet, knee valve, basket drain, keyhole wall mount bracket, NSF, cCSAus

1 ea Model 7-PS-17 Welded Side Splash, 7-3/4"H (installed height), both sides

1 ea 7-PS-35 Paper Towel Dispenser, wall mounted, locking, 11"W x 4"D x 15"H, for use with "C" fold towels, paper towel level indicator, satin finish stainless steel. includes (2) keys & mounting hardware

ITEM C3 - WORK TABLE, STAINLESS STEEL TOP (1 REQ'D)
Advance Tabco Model TKMS-369 Dimensions: 40.5(h) x 108(w) x 36(d)
Worktable, 108"W x 36"D, 16-gauge 304 stainless steel top with 5"H backsplash, stainless steel legs with side & rear crossrails, adjustable stainless steel bullet feet, NSF

1 ea Model TA-61 Modification to reduce length and/or width of table, start with next largest size then add "TA-61" to model number - 38" Deep
1 ea Model TA-31 Side Splash, 5" hh (each)
Approved Alternate – Custom Fabrication

ITEM C3.1 -SHELVING, WALL MOUNTED (1 REQ'D)
Advance Tabco Model WS-15-72-16 Dimensions: 13.5(h) x 72(w) x 15(d)
Shelf, wall-mounted, 72"W x 15"D, 1-5/8" bullnose front edge, 1-1/2"H rear up-turn, 16/304 satin finish stainless steel,
Approved Alternate – Custom Fabrication

ITEM C4 - PROOFER CABINET, MOBILE, HALF-HEIGHT (1 REQ'D)
Winston Foodservice Model HOV7-04UV Dimensions: 35.7(h) x 27.7(w) x 34.23(d)
CVap® Holding Cabinet, mobile, half-size, insulated, convection holding, accommodates (4) 18" x 26" sheet pans or (8) 13" x 18" sheet pans or (8) 12" x 20" hotel pans, load limit 65 lbs (29.25 kg) per rack, (1) field reversible hinged solid door, magnetic door handle, C-Touch control with processor, HACCP temperature downloads, CVap technology, wireless programming, USB & audio ports, on/off fan control, manual water fill, stainless steel interior & exterior, CE, UL EPH ANSI/NSF4, cUL, UL-Sanitation

1 ea 1-year limited warranty is standard (excluding gaskets, lamps, hoses, power cords, glass panels & evaporators) - for equipment operated in the US & Canada
1 ea 120v/60/1-ph, 2292 watts, 19.1 amps, NEMA 5-20P
1 ea Window in door
1 ea 1" wheels
1 ea Automatic water fill system, in lieu of standard manual fill
1 ea PS2429 water filter

ITEM C5 - UNDERCOUNTER REFRIGERATOR(1 REQ'D)
True Mfg. - Model TUC-60D-2-HC Dimensions: 29.75(h) x 60.38(w) x 30.13(d)
Undercounter Refrerator, 33 - 38°F, (1) stainless steel door, (2) PVC coated adjustable wire shelves, (2) drawers each, accommodates (1) 12" x 20" x 6" food pan (NOT included), stainless steel front, top & sides, aluminum interior with stainless steel floor, 5" castors, R290 Hydrocarbon REFRIGERANT, 1/4 HP, 115v/60/1-ph, 4.0 amps, NEMA 5-15P, cULus, UL EPH Classified, Made in USA

1 ea Drawers left section; doors right section, standard.
1 ea Self-contained Refrigerationstandard.
1 ea Warranty - 7-year compressor (self-contained only), please visit www.Truemfg.com for specifics.
1 ea Warranty - 3-year parts and labor, please visit www.Truemfg.com for specifics.
1 ea Castors, 2-1/2", set of 4.

ITEM C8 - FOOD SLICER, ELECTRIC (1 REQ'D)
Hobart Model HS9-1 Dimensions: 27.25(h) x 24.63(w) x 30.31(d)
(**Please Consider the HS7-1R device as a substitute**) Heavy Duty Meat Slicer, automatic, 13" CleanCut™ removable knife with removal tool, anodized finish with (6) interlocks, (3) stroke lengths & (4) stroke speeds, removable meat grip assembly, removable ring guard cover, product fence, single action top mounted sharpener with Borazon™ stones, manual lift lever, 1/2 hp motor, 120v/60hz/1-ph NSF cETLus.

1 ea Standard warranty - 1-Year parts, labor & travel time during normal working hours within the USA.

ITEM C9 - FOOD PROCESSOR, BENCHTOP / COUNTERTOP (1 REQ'D)
Robot Coupe Model R2N Dimensions: 19.25(h) x 8.75(w) x 15.75(d)
Commercial Food Processor, 3 liter gray polycarbonate bowl with handle, vegetable prep attachment with external ejection, kidney-shaped opening, includes: (1) "S" blade (27055), (1) 2mm grating disc (27577), (1) 4mm slicing disc (27566), continuous feed, bowl attachment designed for vertical cutting & mixing, on/off & pulse switch, single speed, 1725 RPM, 120v/60/1-ph, 7.0 amps, 1 HP, NEMA 5-15P, cETLus, ETL-Sanitation.

1 ea 1-year parts & labor warranty.
1 ea 3-year motor warranty.

ITEM C10 - FOOD PROCESSOR, BENCHTOP / COUNTERTOP (1 REQ'D)
Piper Products Model GSM 5 STAR Dimensions: 21.26(h) x 10.83(w) x 19.06(d)
Chef's Choice Vegetable Cutter, ergonomic 45° angle, on-off latch, safety interlocks, processes up to 330 lbs. per hour, 340 RPM, cast stainless steel construction, gear-drive, CE, NSF, UL, HACCP (discs sold separately).

1 ea 2-year warranty parts & labor from date of purchase.
1 ea 115v/60/1-ph, 3.0 amps, 1/2 hp, cord & plug.

ITEM C11 - WORK TABLE, STAINLESS STEEL TOP (1 REQ'D)
Advance Tabco Model TKMS-307 Dimensions: 40.5(h) x 96(w) x 30(d)
Worktable, 72"W x 30"D, 16-gauge 304 stainless steel top with 5"H backsplash, stainless steel legs with side & rear cross rails, adjustable stainless steel bullet feet, NSF
Approved Alternate – Custom Fabrication

ITEM C11.1 - WELD-IN SINK (1 REQ'D)
Advance Tabco Model TA-11E-2 Dimensions: 14(h) x 54(w) x 25.75(d)
Double Sink Welded into Tabletop, 24"W x 24"D x 14" deep bowls, includes faucet, NSF

1 ea Model K-4 Support Bracket, for lever waste drain handle, (1) support required for each lever drain
2 ea Model FC-455F Sink Cover, stainless steel, for 24" x 24" fabricated bowl
Approved Alternate – Custom Fabrication

ITEM C11.2 - WALL / SPLASH MOUNT FAUCET (1 REQ'D)
T&S Brass Model B-0291
Kettle & Pot Sink Faucet, B-Flo, wall mounted 8" centers, 3/4" IPS model LL street EL inlets with locknuts, 18" swing nozzle, 175°F four arm handles, 1-1/4" dia. holes required in backsplash

ITEM C11.3 - DRAIN, LEVER / TWIST WASTE (2 REQ'D)
Fisher Model 22209
DrainKing Waste Valve, with flat strainer, 12 GPM drain rate, dual teflon seals, stainless steel ball, cast red brass body

ITEM C12 - SHELVING, WALL MOUNTED (1 REQ'D)

Advance Tabco Model WS-15-84-16 Dimensions: 13.5(h) x 84(w) x 15(d)
Shelf, wall-mounted, 84"W x 84"D, 1-5/8" bullnose front edge, 1-1/2"H rear up-turn, 16/304 satin finish stainless steel, NSF (units 84" & longer have (3) support brackets)
Approved Alternate – Custom Fabrication

ITEM C21 - WORK TABLE, STAINLESS STEEL TOP (1 REQ'D)
Advance Tabco Model TKMS-369 Dimensions: 40.5(h) x 108(w) x 36(d)
Worktable, 108"W x 36"D, 16 gauge 304 stainless steel top with 5"H backsplash, stainless steel legs with side & rear cross rails, adjustable stainless steel bullet feet, NSF
Approved Alternate – Custom Fabrication

ITEM C21.1 - SHELVING, WALL MOUNTED (1 REQ'D)
Advance Tabco Model WS-15-84-16 Dimensions: 13.5(h) x 84(w) x 15(d)
Shelf, wall-mounted, 84"W x 15"D, 1-5/8" bullnose front edge, 1-1/2"H rear up-turn, 16/304 satin finish stainless steel, NSF (units 84" & longer have (3) support brackets)
Approved Alternate – Custom Fabrication

ITEM C22 - UNDERCOUNTER REFRIGERATOR(1 REQ'D)
True Mfg. - Model TUC-44D-2-HC Dimensions: 29.75(h) x 44.5(w) x 32.25(d)
Deep Undercounter Refrerator, 33 - 38°F, side mounted self-contained refreration, (2) drawers each accommodates 12" x 20" x 8" pan (NOT included), steel handles, electronic temperature control with digital temperature display, stainless steel sides & back, stainless steel interior, 5" castors, R290 Hydrocarbon REFRIGERANT, 1/10 HP, 115v/60/1-ph, 1.7 amps, NEMA 5-15P, cULus, UL EPH Classified, Made in USA

1 ea Self-contained Refrigerationstandard
1 ea Warranty - 7-year compressor (self-contained only), please visit www.Truemfg.com for specifics
1 ea Warranty - 3-year parts and labor, please visit www.Truemfg.com for specifics
1 set Castors, 2-1/2", set of 4

ITEM C31 - CUSTOM (1 REQ'D)
ITD Food Safety Model PREP N TEMP PRO STATION
NIC, by Operations

ITEM C32 - PLANETARY MIXER (1 REQ'D)
Hobart Model HL400-1STD
200-240/50/60/3 Mixer; with bowl, beater, whip, & spiral dough arm; US/EXP configuration - Legacy Planetary Mixer, 1.5 hp, 40-quart capacity, (3) fixed speeds, gear-driven transmission, 20-minute timer, #12 taper attachment hub, manual bowl lift, bowl guard, stainless steel bowl, "B" beater, "D" whip, "ED" dough hook

1 ea Standard warranty: 1-Year parts, labor & travel time during normal working hours within the USA

ITEM C40 - WORK TABLE, STAINLESS STEEL TOP (1 REQ'D)
Advance Tabco Model TKMS-245 Dimensions: 40.5(h) x 60(w) x 24(d)
Worktable, 72"W x 24"D, 16-gauge 304 stainless steel top with 5"H backsplash, stainless steel legs with side & rear cross rails, adjustable stainless steel bullet feet, NSF
Approved Alternate – Custom Fabrication

ITEM C40.1 - SCALE AND MONITOR, LEAN (1 REQ'D)
Custom Model
NIC, by operations

ITEM C40.2 - COMMERCIAL WASTE CONTAINER (2 REQ'D)
Rubbermaid Commercial Products Model FG263200BLUE Dimensions: 27.25(h) x 22(w) ProSave® BRUTE® Container, without lid, 32-gallon, 22"D x 27-1/4"H, round, reinforced rims, built in handles, double rimmed base, hh-impact plastic construction, blue, NSF, Made in USA (contact Rubbermaid for broken case information)

2 ea Model FG264043BLA BRUTE® Quiet Dolly, 18-1/4"D x 6-5/8"H, non-marking casters, black, NSF, Made in USA

ITEM D1 - DISHTABLE, SOILED (1 REQ'D)
Custom Fabrication-Soiled Dishtable, L Shape, 60" machine to corner, 96" corner to end, 30" working depth, 43"H, left-to-right operation, 14/304 stainless steel top, 10"H backsplash with 2" sanitary return, 8" OC splash mount faucet holes, 20" wide x 20" front-to-back x 5" deep fabricated pre-rinse sink, fully welded stainless steel gussets, 16/304 stainless steel legs & side cross bracing, adjustable stainless steel feet, Aero Hemmed Safety Edge™, KD, NSF

1 ea Modify Sink Location per Drawing
1 ea Cutout in Backsplash for Dish Drop Opening
Refer to drawings and elevations for all final details

ITEM D1.1 -PRE-RINSE FAUCET (1 REQ'D)
T&S Brass Model B-0133-CR
EasyInstall Pre-Rinse Unit, wall mount mixing faucet, 8" adjustable centers, 56" flexible stainless steel hose, 1.15 GPM spray valve (B-0107), quarter-turn Cerama cartridges with check valves, lever handles with color-coded indexes, 18" riser, 9" wall bracket, polished chrome-plated brass faucet body, 1/2" NPT female inlets, low lead

ITEM D1.2 - DISH DROP SHELF & TRIM (1 REQ'D)
Custom Fabrication - 16GA S/S
To include s/s trim on dish drop trim enclosure, Low Pass Shelf & Mid Shelf - All dimensions per Plan & Elevation
Drop Height to be ADA Compatible at 34” AFF
To be Verified in Field prior to fabrication

ITEM D1.3 - SOAK SINK (1 REQ’D)
Advance Tabco Model 9-FSC-20
Soak Sink with Silver Chute, mobile, 24"W x 24"D x 20"H, 14/304 stainless steel construction, 20" x 20" x 8" deep compartment, 2" euro-style edges, lever drain, stainless steel perforated lift-out basket, removable stainless steel silver chute, 16/304 stainless steel tubular legs with cross braces, (4) 5" casters (2 with brakes), NSF. Includes Silver Chute 9-SS-1

ITEM D1.4 – SLANTED OVER SHELF, TABLE-MOUNTED (1 REQ’D)

Custom Fabrication
Table Mounted to Soiled Table.

ITEM D1.5 – TRASH CAN, 32 GALLON (1 REQ'D)
Rubbermaid model Brute w/Caster plate

ITEM D2 - DISHWASHER, CONVEYOR TYPE (1 REQ'D)
Hobart Model CL44-ADV+BUILDUP Dimensions: 68.5(h) x 44.75(w) x 31.25(d)
Conveyor Dishwasher, Advansys model, single tank, (202) racks/hour, insulated hinged doors, .62 gallon/rack, stainless steel enclosure panels, microprocessor controls with low temperature & dirty water indicators, NSF Pot & Pan mode, programable de-lime notification, 30 kW stainless booster, energy recovery (DWER), automatic soil removal (ASR), drain water tempering kit, ENERGY STAR®, Free factory startup for installations within a 100 mile radius of a Hobart service office; installation beyond 100 miles will be charged at the quoted rate by the local Hobart service office 1 ea Standard warranty - 1-Year parts, labor & travel time during normal working hours within the USA

1 ea Model CL44-ADVHTE15K Electric tank heat 15kW
1 ea Model CL44-ADVERH30K 30kW electric booster
1 ea Model CL44-ADVELE0CD 480v/60/3-ph
1 ea Single Point (1) service connection standard (Field convertible options available)
1 ea Model CL44-ADVHGTSTD Standard height
1 ea Model CL44-ADVDIR0LR Left to right operation
2 st Model FLGFT-CLE*2 Flanged Feet, all CLeN models (44", 54", & 64") require quantity of 2 sets (4 feet)
1 ea NOTE: For water of 3-grains of hardness or more, Hobart suggests adding a water softener.

ITEM D2.1 -DISHWASHER, BLOWER DRYER (1 REQ'D)
Hobart Model BDERLET-STDDOM
Blower Dryer, electric, L - R 480v/60/3-ph, standard hgt, Domestic

ITEM D3 - CONDENSATE HOOD (1 REQ'D)
Streivor Model Custom
Refer to Factory Shop Drawings for Final Details

ITEM D3.1 -STAINLESS PANTLEG DUCT CONNECTIONS (1 REQ'D)
Streivor Hoods
Final Specifications by K.E.C
Refer to Factory Shop Drawings for Details

ITEM D4 - DISHTABLE, ROLLER TABLE (1 REQ'D)
Custom Fabrication
Refer to Factory Shop Drawings for Details

ITEM D4.1 - OVERSHELF, TABLE-MOUNTED (1 REQ'D)
Custom Fabrication Model - 3SKTW-2142 Slant Wall Shelves, K.D. tubular design, stainless steel

1 ea Table Mounted to Roller Clean Table

ITEM D4.2 -RACK DOLLY (1 REQ'D)
Cambro Model CDR2020151 Dimensions: 8(h) x 21.38(w) x 21.38(d)
Camdolly® for Camracks, 21-3/8"L x 21-3/8"W x 8"H (exterior dimensions), without handle, platform design, (4) swivel 3-1/2" casters, no brakes, lhtweht, durable, soft gray polypropylene

ITEM D5 - HOSE REEL (1 REQ'D)
T&S Brass Model B-1433-7132M-CR Hose Reel Assembly, open, 3/8" x 35 ft. hose with 1.15 GPM spray valve, 8" wall mount mixing faucet, adjustable centers, quarter-turn Cerama cartridges with check valves, lever handles with color coded indexes, EasyInstall 16" and rigid 40" risers, 36" flexible water hose connector with stainless steel quick disconnect, with ratcheting system & adjustable hose bumper, (2) 2-3/8" wall brackets, 1/2" NPT

ITEM D8 - THREE COMPARTMENT SINK
Advance Tabco Model FC-3-2030-24RL Dimensions: 42(h) x 108(w) x 36(d)
Fabricated Sink, 3-compartment, 24" right & left drainboards, bowl size 20" x 30" x 14" deep, 16-gauge 304 stainless steel, tile edge splash, rolled edge, 8" OC faucet holes, stainless steel legs with adjustable side cross-bracing, 1" adjustable stainless steel bullet feet, overall 36" F/B x 108" L/R, NSF

ITEM D8.1 - WALL / SPLASH MOUNT FAUCET (1 REQ'D)
T&S Brass Model B-0291 - Kettle & Pot Sink Faucet, B-Flo, wall mounted 8" centers, 3/4" IPS model LL street EL inlets with locknuts, 18" swing nozzle, 175°F four arm handles, 1-1/4" dia. holes required in backsplash

ITEM D8.2 - DRAIN, LEVER / TWIST WASTE (3 REQ'D)
Fisher Model 22209 DrainKing Waste Valve, with flat strainer, 12 GPM drain rate, dual teflon seals, stainless steel ball, cast red brass body

ITEM D8.3 - OVERSHELF (1 REQ'D)
Advance Tabco PS-18-108 Shelf with Pot Rack, wall-mounted, 108"W x 18"D, 18/430 stainless steel shelf, 2" x 1/4" stainless steel pot rack, includes: (9) plated double pot hooks (units 96" & longer have (3) support brackets), NSF

ITEM D9 - TRASH RECEPTACLE, INDOOR (13 REQ'D)
Rubbermaid Commercial Products Model FG354060GRAY Dimensions: 30(h) x 22(w) x 11(d), Slim Jim® Container, 23-gallon, 22"W x 11"D x 30"H, with venting channels, molded-in handles, general purpose waste, open type without lid, hh-impact plastic construction, gray, Made in USA

ITEM D10 - FLOOR TROUGH (2 REQ'D)
Advance Tabco Model FFTG-1260 Dimensions: 4(h) x 60(w) x 12(d)
Floor Trough, 60"W x 12"D x 4" deep, with fiberglass grating, stainless steel removable strainer basket, 4" O.D. waste pipe 3"L, pitched towards waste, NSF

ITEM D11 - HAND SINK (1 REQ'D)
Advance Tabco Model 7-PS-62 Dimensions: 26.5(h) x 17.25(w) x 15.25(d)
Hand Sink, wall mounted, 14" wide x 10" front-to-back x 5" deep bowl, 20-gauge 304 stainless. steel, Knee Valve, lever drain with overflow, P-trap, wall bracket, NSF, cCSAus

1 ea Model 7-PS-17 Welded Side Splash, 7-3/4"H (installed height), both sides, for hand sinks with 14" wide x 10" front-to-back bowl, splash mounted faucets

ITEM D12 - SHELVING UNIT, MOBILE (3 REQ'D)
Metro Model MQ-246076G-MP-4 Dimensions: 76(h) x 60(w) x 24(d).
MetroMax® Q Mobile Shelving Unit, 60"W x 24"D x 76"H, (4) open grid shelves with removable polymer shelf mats over one-piece epoxy coated steel frames, (4) polymer posts, Microban antimicrobial product protection, (4) swivel rust resistant polymer casters with 5" (127mm) polyurethane wheels (2 braked), KD, NSF product protection, (4) poly stem casters: (2) swivel (2) brake, NSF.

ITEM D13 - PLATE DOLLY (4 REQ'D)
Metro PCD11A Poker Chip Dish Dolly, 26-5/8"W x 26-5/8"D x 31-15/16"H, adjustable, dish size 4-1/4" to 11-3/4", removable dividers & towers, two-handed access, recessed handles, 5"Dia. swivel casters with neoprene wheels (2 with brakes), chip-resistant polymer shell with Microban® antimicrobial protection, aesthetic blue, vinyl dust/water splash cover, NSF

ITEM D14 - PLASTIC SHELVING UNIT (2 REQ'D)
Metro Model MQ-244876G-MP-4
MetroMax® Q Mobile Shelving Unit, 48"W x 24"D x 76"H, (4) open grid shelves with removable polymer shelf mats over one-piece epoxy coated steel frames, (4) polymer posts, Microban antimicrobial product protection, (4) swivel rust resistant polymer casters with 5" (127mm) polyurethane wheels (2 braked), KD, NSF

ITEM D15 - Bussing Utility Transport Cart, Metal (1 REQ'D)
Lakeside Manufacturing Model 949 Tough Transport® Utility Cart, 3-tier, 42"W x 25-7/8"D x 37-3/8"H, stainless steel construction, open base U-frame with angled stainless steel, 24" x 36" 14-gauge shelves with reinforced edges, 11-3/8" shelf clearance, 1" O.D. tube push handle with bumpers, (2) 6" bumpers riveted to front legs, 1000 lb. capacity, (2) 5" reinforced swivel plate casters & (2) 8" fixed casters with non-marking polyurethane wheels, NSF, Made in USA

ITEM D17 - EYE WASH STATION, RECESSED (1 REQD)
T&S BRASS -EW-7656WC Eyewash Unit, recessed, wall mounted, 32"H x 14"W x 5"D, single valve with strainer, 4.2 gpm flow control, polished chrome-plated brass valve, stainless steel housing, 1/2" NPT inlet, 2" NPT waste outlet, cCSAus

ITEM D19 - TRASH BIN, MOBILE (3 REQ'D)
Rubbermaid - Model #1829410

ITEM D20 - MOP SINK CABINET (1 REQ'D)
Advance Tabco Model 9-OPC-84DL Dimensions: 84(h) x 50.38(w) x 22.75(d)Cabinet with Mop Sink, 50-3/8"W x 22-3/4"D x 84"H O.A., double hinged doors, left side mop sink 20"W x 16"D front to back x 12" deep (drain included), storage for mop bucket to roll in on right, (2) mop holders, (4) fixed intermediate shelves (3 on right, 1 on left above sink), slotted side panels for ventilation, 16/304 series stainless steel sink bowl, 18/304 series sink bowl apron, 18/430 series stainless steel cabinet, NSF

ITEM D20.1 - SERVICE FAUCET (1 REQ'D)
T&S Brass – B-0665-CR-BSTR

Service Sink Faucet, wall mount, 8" OC, 6-1/2" spout, with hose thread & pail hook, vacuum breaker spout, wall braced, chrome-plated brass

ITEM D20.2 - HOSE BIB FAUCET (1 REQ'D)
T&S Brass Model B-0720
Sill Faucet, vacuum breaker, 3/4" garden hose outlet with atmospheric vacuum breaker, 1/2" IPS female flanged inlet, controlled by key or screwdriver slot

ITEM D21 - STORAGE CABINET (1 REQ'D)
Advance Tabco Model CAB-1-300 Dimensions: 84(h) x 25.19(w) x 22.75(d) Free Standing Cabinet, 25-3/16"W x 22-3/4"D x 84"H, (1) left-hinged door, (1) 12"D fixed intermediate shelf, slotted side panels for ventilation, 18/300 series stainless steel, all welded construction, NSF

ITEM D30.2 – MOBILE SOAK SINK (1 EXISTING)
Advance Tabco Model 9-FSC-20

ITEM D36 – REACH IN REFRIGERATOR (1 EXISTING)
True Model – T-23-HC

ITEM D38 – REACH IN REFRIGERATOR (2 EXISTING)
FWE Model MTU-12

ITEM D99 - S/S WALL PANELING (3 REQ’D)
Custom Fabrication - Stainless Steel Wall Paneling
All Dimensions per plan

ITEM E1 - WALK IN (1 REQ'D)
American Panel Corporation Model CUSTOM
See drawing for dims, main sliding door, viewport, recessed into slab. LEDS.
Refer to Factory Shop Drawings for Details

Approved alternates - Norlake, Arctic, Bally

ITEM E1.1 - COOLER EVAPORATOR COIL (1 REQ'D)
American Panel Corporation Model CUSTOM
Refer to Factory Shop Drawings for Details

ITEM E1.2 - COOLER CONDENSER (1 REQ'D)
American Panel Corporation Model CUSTOM
Refer to Factory Shop Drawings for Details

ITEM E2 - WALK IN, FREEZER (1 REQ'D)
American Panel Corporation - Part of Item #E1
See drawing for dims, main sliding door, viewport, recessed into slab. LEDS.
Refer to Factory Shop Drawings for Details
Include Provisions for Duplex Outlet Mounted behind Evap Coil For Freezer Heat Trace Line - See FS-320 for location
APPROVED ALTERNATES - Norlake, Arctic, Bally

ITEM E2.1 - FREEZER EVAPORATOR COIL (1 REQ'D)
American Panel Corporation Model CUSTOM

ITEM E2.2 - FREEZER CONDENSER (1 REQ'D)
American Panel Corporation Model CUSTOM

ITEM E3 - BLAST CHILLER FREEZER, REACH-IN (1 REQ'D)
HURRiCHiLL™ Blast Chiller/Shock Freezer, Reach-in, self-contained, (24) 12" x 20" x 2.5" or (12) 18" x 26" pan capacity, 110 lbs. from 160° F to 38° F blast chill capacity/90 minutes, 90 lbs. 160° F to 0° F freeze capacity/240 minutes, 7" LCD touch screen controller with Quick Start & A La Carte functionality, (1) heated food probe, stainless steel interior & exterior, 6" stainless steel legs, 3 HP, UL CLASSIFIED EPH, cUL, ANSI/NSF

1 ea 1-year parts & labor warranty standard on cabinet only
1 ea 5-year compressor warranty is standard, 1-year parts, labor not included
1 ea Standard Refreration, R404a REFRIGERANT
1 ea 208v/60/3-ph, 10.0 amps, 6' cord, NEMA L15-20P
1 ea USB interface
1 ea 5" Casters (set of 4)

ITEM E5 - SHELVING UNIT, MOBILE (8 REQ'D)
Metro Model MQ-246076G-MP-4
MetroMax® Q Starter Shelving Unit, 60"W x 24"D x 74"H, rust proof, 1000 lb. capacity per shelf, 2000 lb. capacity per unit, (5) open grid polymer shelves with reinforced type 304 stainless steel corners and removable polymer shelf mats, bag of (4) wedge connectors included with each shelf, (4) polymer posts, Microban antimicrobial product protection, KD, NSF

ITEM E6 - SHELVING UNIT, MOBILE (1 REQ'D)
Metro Model MQ-244276G-MP-4 Dimensions: 74(h) x 42(w) x 24(d)
MetroMax® Q Starter Shelving Unit, 42"W x 24"D x 74"H, rust proof, 1000 lb. capacity per shelf, 2000 lb. capacity per unit, (5) open grid polymer shelves with reinforced type 304 stainless steel corners and removable polymer shelf mats, bag of (4) wedge connectors included with each shelf, (4) polymer posts, Microban antimicrobial product protection, KD, NSF

ITEM E7 - NESTING PAN RACK (3 REQ'D)
Advance Tabco Model NR-20 Dimensions: 69.25(h) x 21(w) x 26(d)
Special Value Rack, mobile pan, full height, nesting design, open sides, with angle tray guides on 3" centers, capacity 20 - 18" x 26" sheet pans or 40 - half-size pans, all-welded aluminum construction, front loading, 69-1/4" hh

ITEM E8 - SHELVING UNIT, MOBILE (4 REQ'D)
Metro Model MQ-244876G-MP-4
MetroMax® Q Mobile Shelving Unit, 48"W x 24"D x 76"H, (4) open grid shelves with removable polymer shelf mats over one-piece epoxy coated steel frames, (4) polymer posts, Microban antimicrobial product protection, (4) swivel rust resistant polymer casters with 5" (127mm) polyurethane wheels (2 braked), KD, NSF

ITEM E9 - DUNNAGE RACK (3 REQ'D)
New Age Model 2014 Dimensions: 12h) x 36(w) x 18(d)

Dunnage Rack, 36"W x 18"D x 12"H, all welded aluminum construction, 1-1/2" x 1-3/4" x 0.070 tubing, welded aluminum caps on feet, weht capacity 3000 lbs., NSF, Made in USA

5 ea Lifetime warranty against rust & corrosion, 5-year workmanship and material defects warranty, standard

ITEM E10 - ICE MAKER, CUBE-STYLE (1 REQ'D)
Hoshizaki Model KMD-410MAJ Dimensions: 24(h) x 22.25(w) x 24.13(d)
Ice Maker, Cube-Style, 22"W, air-cooled, self-contained condenser, production capacity up to 418 lb/24 hours at 70°50° (351 lb AHRI certified at 90°/70°), stainless steel finish, crescent cube style, R-404A REFRIGERANT, 115v/60/1-ph, 8.2 amps, NSF, cETLus, UL

1 ea Warranty: 3-Year parts & labor on entire machine
1 ea Warranty: 5-Year parts & labor on evaporator
1 ea Warranty: 5-Year parts on compressor & air-cooled condenser

ITEM E10.1 - ICE BIN FOR ICE MACHINES (1 REQ'D)
Hoshizaki Model BD-300SF Dimensions: 46(h) x 22(w) x 32.5(d)
Ice Bin, 22"W, top-hinged front-opening door, 300-lb ice storage capacity, for top-mounted ice maker, stainless steel exterior, 6" painted flange legs included, protected with H-GUARD Plus Antimicrobial Agent, fits 24" - 24-1/2" deep ice machine without top kit extension, ETL, ETL-Sanitation

1 ea Warranty: 3-Year parts & labor for bin
1 ea Model HS-5607 Scoop Holder Kit
1 ea Model SP-5429 Bin Door Catch (purchase as a service part)
1 pk Model LP-6 FLANGE LEG Flange Leg Package, (4) x 6", stainless steel

ITEM E10.2 - WATER FILTER (1 REQ'D)
Hoshizaki Model H9320-51 Water Filtration System, single configuration, 18.4" H (manifold & cartridge)
3 ea H9655-11- Replacement Water Filter Cartridge, each

FINAL FILTER SPEC PENDING WATER TEST RESULTS - BY GC/KEC

ITEM E11 - FLOOR TROUGH (1 REQ'D / WARM SHELL)
Advance Tabco Model FFTG-1224 Dimensions: 4(h) x 24(w) x 12(d)
Floor Trough, 24"W x 12"D x 4" deep, with fiberglass grating, stainless steel removable strainer basket, 4" O.D. waste pipe 3"L, pitched towards waste, NSF

ITEM E12 - DUNNAGE RACK (2 REQ'D)
New Age Model 2001 Dimensions: 8(h) x 36(w) x 18(d) Dunnage Rack, 36"W x 18"D x 8"H, all welded aluminum construction, 1-1/2" x 1-3/4" x 0.070 tubing, welded aluminum caps on feet, weht capacity 3000 lbs., NSF, Made in USA

2 ea Lifetime warranty against rust & corrosion, 5-year workmanship and material defects warranty, standard

ITEM E14 - SHELVING UNITS (3 REQ’D)

Metro Model MQ-246076G-MP-4
MetroMax® Q Mobile Shelving Unit, 60"W x 24"D x 76"H, (4) open grid shelves with removable polymer shelf mats over one-piece epoxy coated steel frames, (4) polymer posts, Microban antimicrobial product protection, (4) swivel rust resistant polymer casters with 5" (127mm) polyurethane wheels (2 braked), KD, NSF

ITEM G1 - LOCKERS (4 REQ'D)
Vanguard Model SERIES 6411R
3 tier, 18x12x24, 1 column, sloped top, color gray

ITEM G2 - TIME CLOCK (1 REQ'D)
Custom Model CUSTOM
NIC, by operator

ITEM G3 - FIRST AID KIT (1 REQ'D)
Custom Model CUSTOM
NIC, by operator

ITEM H1 - SERVING COUNTER, MILLWORK (1 REQ'D)
Custom Fabricated - See approved manufacturer list
Refer to Plans & Elevations for Final Details

ITEM H1.1 - FAUCET, KETTLE / POT FILLER (2 REQ'D)
Fisher Model 27400
60″ Foodgrade Hose, Stainless Steel Armor Jacket, Extended Length Threaded Insert,1-Lever Handle with 2 Color Coded Identification Buttons, Red for Hot, Blue for Cold, Two Part Swivel Stem(s) for Lower Maintenance, 1/2″ Inlet(s) Standard, Single Wall Control Valve, Stainless Steel Seats – Guaranteed for Life, Pot Filler Valve Guaranteed for 1 MILLION Cycles, Built In Spray Handle Clip, 5.00 GPM Aerated Glass Filler Outlet, Hh Strength Bronze Alloy-NOT Plastic for Full On &- Insulated for Safety, Nylon Handle Friction Disk For Smooth Action, Heavy Duty Lift Pin - Two O-Rings Ensures Sealing, Standard Internal Gaskets

ITEM H1.2 - WATER FILTER (2 REQ'D)
EVERPURE Model EV927501

FINAL FILTER SPEC PENDING WATER TEST RESULTS - BY GC/KEC

ITEM H2 - COFFEE GRINDER (1 REQ'D)
FETCO Model G1202US
Coffee Grinder, portion controlled, (2) 5 lb. capacity removable-dishwasher-safe hopper, (3) portion sizes per side, digital, adjustable grind settings, 8 oz. per minute grind rate (medium), slicing type grinding burrs, adjustable brew basket rails, 0.67 HP motor power, 120v, 1-ph, 2+G wires, 7.2 max amp draw, 0.37kW, NEMA 5-15P, NSF, CE

ITEM H3 - COFFEE BREWER (1 EXISTING)
FETCO Model CBS-2141XTS (E214171) Dimensions: 34.38(h) x 11.75(w) x 20.38(d).

XTS™ Series Coffee Brewer, single, 1.0 gallon capacity, touchscreen operation, customizable screen, adjustable brew time and volume, streamlined programming and diagnostics, manual hot water service, 1 x 1.5kW heater, 120v, 1-ph, 2+G wires, 13.0 max amp draw, 1.6kW, NEMA 5-15P, 3.9 gallons per hour, UL, cUL, NSF (Use with FETCO D448 - sold separately) (Manufactured standard with plastic brew basket - metal brew basket sold separately).

1 ea Circuit board: 3-year parts & 1 year labor warranty, standard.
ea Electro-mechanical parts: 2-year parts & 1 year labor warranty, standard.
1 ea All other parts: 1-year parts & 1 year labor warranty, standard.

ITEM H3.1 - COFFEE DISPENSER (3 REQ'D / 5 EXISTING)
FETCO Model D450 Dimensions: 24.5(h) x 9(w) x 13.25(d).
L4D-20 LUXUS® Thermal Dispenser, 2.0-gallon, Freshness Timer®, Volume Indicator™, vacuum insulated, flip & hide fill-through lid, base with built-in handles and drip tray.

ea 1-year parts warranty, standard.
2 ea Black dispenser faucet, standard.

ITEM H3.2 - WATER FILTER (1 REQ'D)
EVERPURE Model QC7I SINGLE 4FC5-S
1 ea (Replacement Cartridge) (12pk)

FINAL FILTER SPEC PENDING WATER TEST RESULTS - BY GC/KEC

ITEM H4/H4.1 - ICE MACHINE & DISPENSER, NUGGET STYLE (2 REQ'D)
Follett Model 7UD112A-NW-NF-ST-00-G
Champion 7 undercounter ice-only dispenser for ADA applications produces up to 100 lbs of Chewblet nugget ice per day while holding 7 lbs of ice in storage, ideal for work groups up to 50 people. Other key features include antimicrobial Shield product protection, capacitive touch display, and a unique drainless design that allow this model to be installed virtually anywhere there is water and electricity available.

1 ea Kit to add internal Claris filter to Champion ice-only (NW) or ice and water (IW) models

FINAL FILTER SPEC PENDING WATER TEST RESULTS - BY GC/KEC

ITEM H5/H5.1 - WATER DISPENSING SYSTEM (2 REQ'D)
Natura Water Model D5 - 80 L/HR COUNTERTOP SYSTEM Dimensions: 19.9(h) x 17.5(w) x 26.4(d) (808294) D5 Countertop Water Purification System, Chilled Sparkling Water Chilled Still Water and Ambient Water. Self-contained Chiller, countertop, (3) taps, 80-liter cold water capacity per hour, 40-100 psi, 110-120v/60/1-ph, 6.0 amps, 3/8" NPT, cULus, NSF, (requires the purchase of model NWFS-5 FILTER ASSEMBLY) (NET PRICE Reflects Distributor Discount)

1 ea Model NWFS-5 FILTER ASSEMBLY (804853) Filter Assembly Kit, 3-stage filtration Prefilter/Carbon/NanoCeram®, for all systems. NET PRICE Reflects Distributor Discount

ITEM H6 - BEVERAGE DISPENSER, NON-INSULATED (3 REQ'D)
Cal-Mil Model 1132-3-13 Dimensions: 25.5(h) x 10.25(w) x 10.5(d)

Beverage Dispenser, 3-gallon capacity, 10-1/4"W x 10-1/2"D x 25-1/2"H, ice chamber, drip tray, black metal base, acrylic

ITEM H7 – CO2 TANK (2 REQ'D)
NIC, Final Specification By Owner/Vendor

ITEM H8 - UNDERCOUNTER REFRERATOR, GLASS DOOR (1 EXISTING / 1 REQ'D)
True Mfg. - Model TUC-27G-LP-HC-FGD01 Dimensions: 29.75(h) x 27.63(w) x 29.13(d)
Low Profile Undercounter Glass Door Refrerator, 31-7/8" counter height, 33 - 38°F, door lock standard, (2) PVC coated adjustable wire shelves, LED interior lighting, stainless steel sides & back, stainless steel interior, 1-1/2" dual swivel castors, R290 Hydrocarbon REFRIGERANT, 1/6 HP, 115v/60/1-ph, 2.0 amps, NEMA 5-15P, cULus, UL EPH Classified, CE, Made in USA.

1 ea NOTE: All True pricing is tentative based on final production date of units ordered. Any units ordered that will be produced on or after July 1, 2022, may include escalators above Jan22 pricing. Please contact your True representative for final lead times.
1 ea Right Hand, Standard: Unit comes with field reversible hinges (New door must be ordered) and is built with hinging on right side of unit.
1 ea Self-contained Refrigerationstandard
1 ea Warranty – 7-year compressor (self-contained only), please visit www.Truemfg.com for specifics.
1 ea Warranty – 3-year parts and labor, please visit www.Truemfg.com for specifics.

Requires Lower ⅓ of glass to be frosted with decal, by others

ITEM H10 - SERVING COUNTER, MILLWORK (1 REQ'D)
Custom Fabricated - See approved manufacturer list
Refer to Plans & Elevations for Final Details

ITEM H11 - SOFT SERVE MACHINE (1 REQ'D)
Stoelting Model F231-38I2-2X Dimensions: 57.75(h) x 25.63(w) x 33.75(d)
Soft-Serve/Yogurt Freezer, floor model, 25-5/8"W x 33-3/4"D x 57-3/4"H, air cooled, Intelli-Tec2™ control with LCD display, (2) flavors with twist, gravity, (2) 20 quart hoppers & (2) 3.4 quart freezing cylinder, self-closing spot, spot handle, clear door, energy conservation mode, precision controlled, air plenum, Refrigerationsystem, standard carburetors, stainless steel exterior, casters, 12,000 BTU/hr, R-448A compressor, (2) 3/4 hp motors, 208-240v/60/1-ph, 13.52 amps, cord with NEMA 6-20P, cULus, NSF, ADA Compliant (Mix inlet regulator required)

1 ea 1-year parts & labor warranty, standard (North America Only)
1 ea 5-year warranty on compressor, evaporator/hopper assembly, drive motor, speed reducer, auger shaft & auger flhts (against breakage) standard
1 ea Model F231-38I2-2X/START-UP FEE Factory Start-up Fee, for F231-38I2-2X (net)
2 ea Model 2149243-01 2A Carb Assembly 3/16" hole, for models E131, F131, F144, SF144, F231 & SF121 (included)

ITEM H12 - FROST TOP / COLD SLAB, DROP IN (1 REQ'D)
Hatco Model FTBP-1 Dimensions: 17.25(h) x 21.06(w) x 28.94(d)
Drop-In Frost Top, 21-1/16"L, accommodates (1) full size sheet pan, lhted on/off rocker switch, electronic adjustable temperature control can be mounted to either side of condensing unit or remotely up to 4' from unit, auto-defrost, self-contained refreration, R513a, 1/4 HP, cULus, Made in USA

1 ea NOTE: Sale of this product must comply with Hatco's Minimum Resale Price Policy; consult order acknowledgement for details
1 ea NOTE: Includes 24/7 parts & service assistance, call 800-558-0607
1 ea One-year parts & labor warranty, standard
1 ea CE mark not available
1 ea 120v/60/1-ph, 300 watts, 3.8 amps, NEMA 5-15P, 1/5 HP (domestic voltage) standard

Approved Alternate – Duke – Model #RFT1-SL

ITEM H13 - SNEEZE GUARD, STATIONARY (2 REQ'D)
BSI Model Custom EA-101A - Size Per Drawings BQ789335
Construction & Materials**:** Custom stainless steel 1” square posts, Matte black finish.
3/8" tempered glass front panels and top shelf with square corners.
Incorporate BSI Patented Helios LED light. Infinite controls and on/off switches mounted remotely in counter apron.

ITEM H14 - COFFEE BREWER (1 EXISTING / REQ’D)
BUNN Model 44400.0203 Dimensions: 40.3(h) x 20.1(w) x 23.8(d).
Model 312 Bean to Cup Coffee Brewer, with BUNNlink® remote monitoring, (2) 3 lb. bean hoppers & (1) 2 lb. bean hopper, (2) 5 lb. powder hoppers, (63) 8 oz. cups per hour, up to 8-1/4" cup clearance, Air Infusion® extraction control, (5) programmable portion sizes, 17" touchscreen, hot water button, stainless steel & black finish, 4" black legs, VirtualTOUCH™ compatible, 1800kW, 120v/60/1-ph, 15 amps, cord, NEMA 5-15P, ETLus, NSF.

1 ea Model Google Model # 44400.0203 - SURE IMMERSION 312, 120V 60HZ

1 ea BUNN 53460.1000 KIT, Funnel Magnetic

ITEM H14.1 - WATER FILTER (1 REQ'D)
Bunn Model - 56000.0024
1ea replacement cartridge pack

ITEM H15 - ESPRESSO CAPPUCCINO MACHINE (1 EXISTING / REQ’D)
Grindmaster-UNIC-Crathco Model Classic +1 w/SteamGlide 26(h) x 14(w) x 23(d).
Single group espresso maker with large steam boiler, 4 programmable volume keys, Semi-automatic key for manual control, Integrated shot timer, 1 Stainless steel steam arm operated through switch with on, off and pulse positions, 1 Hot water dispenser with flow regulation, Direct to boiler mounted group head for shot temperature stability, Overabundant steam supply to eliminate recovery time, Adaptable for various coffee profiles – multiple infusion options, Cup

Warmer, Stainless steel panels and welded steel framework, Direct drain pan to hose connection, Automatic Refill, Twin pressure gauge for pump and steam, Full sized rotary vane pump, 1 single filter holder (7 gram basket), 1 double filter holders (14-16 gram basket), 1 Blank filter basket, Stainless steel braided hose for water (1/2" NPT) and drain line, 115 Volt 20 AMP cord cap1 ea Installation, parts & labor warranty for 1 year, standard.

1 ea Model INSTALLTERMS The installation, start, & adjust program includes limited installation, equipment inspection, equipment start-up, & operator training at a single location 35 miles or less from a GMCW™ Authorized Service Provider.

1 ea Year 3 Extended Warranty with preventative maintenance. Two visits per year, includes replacement of the brew gaskets. Grinder burrs & water filtration are reviewed separately from this program (NET)

ITEM H15.1 - COFFEE GRINDER (2 REQ'D)
F&O Imports Model SUPER JOLLY V PRO Dimensions: 24(h) x 9.5(w) x 16.5(d).
Mazzer Super Jolly V Pro Espresso Coffee Grinder, 2.4 lb hopper capacity, 64mm flat grinding burrs, grind on demand, grind flow control, stepless micrometrical grind adjustment, programmable electronic touch pad, removable hopper, 110v/60/1-ph, 350 watts, CE, UL, ETL-Sanitation.

ea 1-year parts & labor warranty for defects, standard.

2 ea silver gloss enamel.

ITEM H15.2 - KNOCK BOX, DROP IN (1 REQ'D)
Espresso Parts Model EPKB665B
Barista Basics Square Knockbox, 6"W x 6"D x 5"H, open bottom design, 5mm thick, durable ABS plastic, 5mm thick, durable ABS plastic, NBR rubber and ABS plastic combine for reduced impact noise, dishwasher safe

ITEM H15.3 - WATER FILTER (1 REQ'D)
EVERPURE Model QC7I SINGLE 4FC5-S

FINAL FILTER SPEC PENDING WATER TEST RESULTS - BY GC/KEC

ITEM H17 - UNDERMOUNT SINK, ADA (1 REQ'D)
Advance Tabco Model - 1014B-05
Sink, undermount, 1-compartment, 20" wide x 20" front-to-back x 5" deep, 3-1/2" drain opening, 22-1/2" x 22-1/2" O.D. trim size, 18-gauge 304 stainless steel (can be used as undermount on non-stainless tops).

ITEM H17.1 - HANDS FREE ELECTRONIC FAUCET (1 REQ'D)
T&S Brass Model EC-3100-7XF1THG.
ChekPoint™ Electronic Faucet, deck mount, rigid gooseneck, 8" center deck plate, single hole, chrome-plated brass, AC/DC control module, internal flow control setting switches, above deck side mount, adjustable thermostatic mixing valve, integral check valves, 18" long flex connector hoses, vandal resistant aerated, .5 GPM, low lead, ADA Compliant.

ITEM H17.2 – PAPER TOWEL DISPENSER, WALL MOUNT (1 REQ'D)

Advance Tabco Model 7-PS-3
Paper Towel Dispenser, wall mounted, locking, 11"W x 4"D x 15"H, for use with "C" fold towels, paper towel level indicator, satin finish stainless steel. includes (2) keys & mounting hardware

ITEM H20 - WATER DISPENSER (1 UNIT – BY OWNER)
Bevi Water Model THE STANDUP 2.0.
Water supply. 3/8″ outer diameter water line. Power supply. Standard 3-prong electrical outlet. Floor-standing dimensions. 22” wide x 61” tall x 22” deep. Fill station dimensions. 9” wide x 13” tall x 3” deep. 2.4GHz wireless network; 802.11b/g/n compatible. Integral Water filter.

ITEM H21 - SNEEZE GUARD, PORTABLE (2 REQ'D)
BSI Manufacturing Model EIG36 Dimensions: E-Series InstaGuard Portable Sneeze Guard, self service, curved acrylic, 36”W, 14” deep base, 14-1/4”-25-1/4” adjustable height, Matte Black posts, protective felt base

1 ea Length: 36"
1 ea Metal finish: Black powder-coated, standard

ITEM H23 - REACH-IN REFRIGERATOR (1 EXISTING / 1 REQ’D)
True Mfg. - Model T-23-HC Dimensions: 78.38(h) x 27(w) x 29.88(d) Refrerator, reach-in, one-section, , (5) PVC coated adjustable wire shelves, LED interior lighting, stainless steel front, aluminum sides, aluminum interior with stainless steel floor, 4" castors, R290 Hydrocarbon REFRIGERANT, 1/4 HP, 115v/60/1-ph, 2.2 amps, NEMA 5-15P, cULus, UL EPH Classified, Made in USA

1 ea Self-contained Refrigerationstandard
1 ea Warranty - 7-year compressor (self-contained only)
1 ea Warranty - 5-year parts & labor, please visit www.Truemfg.com for specifics
1 ea Left door hinging
3 ea Additional PVC coated wire shelf, each (shelf clips included) 1 ea 4" stem castors, standard (adds 5" to OA height)

ITEM H24 - BUS BOX / TUB (2 REQ'D)
Vollrath Model 1521B-31
Traex® Deluxe Bus Box, 1-compartment, 21-3/4"W x 15-5/8"D x 5"deep, temperature range: -30° to 183°F, reinforced top & bottom, high-density polyethylene, gray, NSF, Made in USA (bulk pack - minimum order of 150) (Refer to vollrathfoodservice.com for full warranty policy)

ITEM H25 - MICROWAVE OVEN (2 REQ’D)
Panasonic Model NE-1054F Dimensions: 12(h) x 20.13(w) x 16.5(d).
PRO Commercial Microwave Oven, 1000 watts, 0.8 cu. ft. capacity, (6) power levels, 2- & 3-stage cooking, 20 program memory capacity, touch control pad with Braille, 99-minute timer,

programmable and manual operation, program list/cycle counter, self-diagnostics, tone control, bottom energy feed, interior lht, see-through door with "grab & go" handle, stainless steel front, 120v/60/1-ph, 13.4 amps, cord, NEMA 5-15P, cULus, NSF.

ea 1-year parts & labor warranty (or 18,000 cycles) whichever comes first and 3-year magnetron warranty (or 54,000 cycles) whichever comes first.

ITEM H26 - SHELVING UNITS (4 REQ'D)
Metro Model MQ-184876G-MP-4
MetroMax® Q Mobile Shelving Unit, 48"W x 18"D x 69"H, unit capacity of 900 lbs., (4) open-grid shelves, (4) MX63UP polymer posts, wedge connectors, built in antimicrobial product protection, (4) poly stem casters: (2) swivel (2) brake, NSF

ITEM H27 - SHELVING UNITS (5 REQ'D)
Metro Model MQ-246076G-MP-4
MetroMax® Q Mobile Shelving Unit, 60"W x 24"D x 69"H, unit capacity of 900 lbs., (4) open-grid shelves, (4) MX63UP polymer posts, wedge connectors, built in antimicrobial product protection, (4) poly stem casters: (2) swivel (2) brake, NSF

ITEM H28 - REACH-IN REFRIGERATOR(1 REQ'D)
True Mfg. - Model T-49G-HC~FGD01
Refrerator, Refrerator, reach-in, two-section, framed glass door version 01, (2) glass doors, (6) PVC coated adjustable wire shelves, LED interior lighting, stainless steel front, aluminum sides, clear coated aluminum interior with stainless steel floor, 4" castors, R290 Hydrocarbon REFRIGERANT, 1/2 HP, 115v/60/1-ph, 5.4 amps, NEMA 5-15P, cULus, UL EPH Classified, Made in USA, ENERGY STAR®

1 ea Self-contained Refrigerationstandard.
1 ea Warranty - 7-year compressor (self-contained only), please visit www.Truemfg.com for specifics.
1 ea Warranty - 5-year parts & labor, please visit www.Truemfg.com for specifics.
3 ea Additional PVC coated wire shelf, each (shelf clips included).
1 ea 4" stem castors, standard (adds 5" to OA height).

ITEM H29 - DUNNAGE RACK (3 REQ'D)
New Age Model 2020 Dimensions: 12(h) x 36(w) x 18(d)
Dunnage Rack, 36"W x 18"D x 12"H, all welded aluminum construction, 1-1/2" x 1-3/4" x 0.070 tubing, welded aluminum caps on feet, weht capacity 3000 lbs., NSF, Made in USA

5 ea Lifetime warranty against rust & corrosion, 5-year workmanship and material defects warranty, standard

ITEM J1 - COUNTERS, MILLWORK (1 REQ'D)
Custom Fabrication, refer to factory shop drawings

Full S/S Base Construction
Solid Surface to be determined

ITEM J2 - DISH CART / DOLLY (2 REQ'D)
Metro Model PCD11A Dimensions: 31.94(h) x 26.63(w) x 26.63(d)
Poker Chip Dish Dolly, 26-5/8"W x 26-5/8"D x 31-15/16"H, adjustable, dish size 4-1/4" to 11-3/4", removable dividers & towers, two-handed access, recessed handles, 5"Dia. swivel casters with neoprene wheels (2 with brakes), chip-resistant polymer shell with Microban® antimicrobial protection, aesthetic blue, vinyl dust/water splash cover, NSF

ITEM J6 - PROOFER CABINET, MOBILE, HALF-HEIGHT (1 REQ'D)
FWE / Food Warming Equipment Co., Inc. Model ETC-UA-4PH Dimensions: 32.5(h) x 29.25(w) x 30.5(d) Proofer/Heater Cabinet, mobile, undercounter, (4) pair universal tray slides, (4) 18" x 26" or (8) 12" x 20" tray capacity, 4-1/2" OC, adjustable on 1-1/2" increments, humidified proofer/heating system, adjustable thermostat, separate controls, non-insulated cabinet, (1) insulated door, recessed hand grip, removable water reservoir, stainless steel interior & exterior, (4) 3.5" swivel casters with brakes, UL, cUL, NSF

1 ea Two-year limited parts & one year labor warranty, standard
1 ea 120v/50/60/1-ph, 15.8 amps, 1900 watts, cord with NEMA 5-20P, standard (US)
1 ea Manual Control, standard
1 ea Standard door(s)

ITEM J9 - PIZZA PREPARATION REFRIGERATOR(1 REQ'D)
True Mfg. - Model TPP-AT-44-HC Dimensions: 38.88(h)x 60.25(w) x 33.63(d)
Pizza Prep, 33 - 41°F pan rail, 19-1/2"D cutting board, (1) full doors with locks, (1) Door with with lock, (2) PVC coated adjustable wire shelves, includes: (8) 1/3 size clear polycarbonate insert pans (top), stainless steel front, sides & back, stainless steel liner & stainless steel floor with coved corners, 5" castors, front breathing, R290 Hydrocarbon REFRIGERANT, 1/4 HP, 115v/60/1-ph, 3.9 amps, NEMA 5-15P, UL EPH Classified, cULus, CE, Made in USA

1 ea 7-year compressor warranty, 3-year parts and labor warranty, standard

ITEM J9.1 - PIZZA PAN RACK (1 REQ'D)
New Age Model 99970 Dimensions: 24.13(h) x 12(w) x 13(d)
Universal Pizza Pan Rack, tabletop, single wide, open sides, accommodates (8) 10" to 18" dia. pans up to 1-5/8"H, aluminum construction, front loading, Made in USA

1 ea Lifetime warranty against rust & corrosion, 5-year workmanship and material defects warranty, standard

ITEM J10 - CONVEYOR OVEN, ELECTRIC (2 REQ'D)
Lincoln Model 1180-1V
Ventless Digital Countertop Impinger® (DCTIV) Oven, electric, single stack, 20"W baking chamber, 50” conveyor (extended), adjustable conveyor speed from 30 seconds to 30 minutes, 200°F (93°C) to 600°F (316°C) temperature range, stainless steel exterior, 208/240/60/1-ph, 6.0kW, 27 amps, NEMA 6-50P, cULus, UL EPH Classified, CE

- Stacked Units
- Left to Right Belt Operation

ITEM J11 - SERVING COUNTER, MILLWORK (1 REQ'D)
Custom Fabricated - See approved manufacturer list
Refer to Plans & Elevations for Final Details

ITEM J12 - SERVING COUNTER, MILLWORK (1 REQ'D)
Custom Fabricated - See approved manufacturer list
Refer to Plans & Elevations for Final Details

ITEM J14, J14.1 – FOOD SHEILD (2 REQ'D)
BSI Model Custom EA-101A - Size Per Drawings BQ789335
Construction & Materials**:** Custom stainless steel 1" square posts, Matte black finish.
3/8" tempered glass front panels and top shelf with square corners.
Incorporate BSI Patented Helios HEAT/LED light. Infinite controls and on/off switches mounted remotely in counter apron.
Manufactured to meet current NSF and UL standards for food shields including end panels and bear appropriate insignia.

ITEM J15 - FOOD SHEILD, PORTABLE (3 REQ'D)
BSI Model Custom EA-100 - Size Per Drawings BQ789335
Custom stainless steel 1" square posts, Matte black finish. 3/8" tempered glass front panels
Manufactured to meet current NSF and UL standards for food shields including end panels and bear appropriate insignia.

ITEM J16 - HEATED SHELF FOOD WARMER (2 REQ'D)
Hatco Model GRSBF-36-S Dimensions: 2.25(h) x 37.5(w) x 25.5(d)
Glo-Ray® Built In Heated Shelf with Flush Top, 37-1/2" x 25-1/2" surface area, hardcoat aluminum top, control thermostat, illuminated on/off switch & mounting bracket, 950 watts, NSF, CE, cUL, UL, UL EPH Classified, CSA

1 ea NOTE: Sale of this product must comply with Hatco's Minimum Resale Price Policy; consult order acknowledgement for details
1 ea NOTE: Includes 24/7 parts & service assistance, call 414-671-6350
2 ea 1-Yr Warranty on Blanket Heating Elements against burnout, standard
2 ea 120v/60/1-ph, 950 watts, 7.9 amps, NEMA 5-15P (domestic voltage), standard
2 ea NOTE: Recommended for use in metallic countertop, verify that the material is suitable for temperatures up to 200-degree F
2 ea Thermostat control with lhted rocker switch (available at time of purchase only), standard

Approved Alternate – Duke – Model # RIGHT2-SB

ITEM J17 - HOT / COLD SHELF (2 REQ'D)
Hatco Model HCSBF-36-S Dimensions: 7.29(h) x 37.5(w) x 25.5(d)

Hot/Cold Shelf, built-in flush top, 36"W x 24"D, electronic temperature control (shipped loose),, aluminum hardcoat, top mount, cULus, Made in USA

1 ea NOTE: Sale of this product must comply with Hatco's Minimum Resale Price Policy; consult order acknowledgement for details
1 ea NOTE: Includes 24/7 parts & service assistance, call 800-558-0607
5 ea 1-year on-site parts & labor warranty
5 ea 1-Yr Warranty on Blanket Heating Elements against burnout, standard
5 ea 120v/60/1-ph, 825 watts, 6.9 amps (domestic voltage), standard

Approved Alternate – Duke – Model # RHF2-SB

ITEM J19 - SERVING COUNTER, MILLWORK (1 REQ'D)
Custom Fabricated - See approved manufacturer list
Refer to Plans & Elevations for Final Details

ITEM J20 - DOUGH BOX DOLLY (1 REQ'D)
Cambro Model CD1826PDB157 Dimensions: 10.25(h) x 27.88(w) x 19.88(d)
Camdolly®, 27-7/8"L x 19-7/8"W x 10-1/4"H (exterior dimensions), for pizza dough boxes, 5" casters (2 fixed, 2 swivel, 1 with brake), coffee bee, NSF

ITEM J21 - DOUGH ROLLER (1 REQ'D)
Somerset Model CDR-1550M Dimensions: 25.5(h) x 17.5(w) x 16(d)
Somerset® Dough Roller, 15" metallic rollers, sheets 500-600 pieces per hour up to 15", front operation, safety sensors, spring loaded synthetic scrapers, large hopper, 4" adjustable stainless steel legs, heavy-duty all stainless steel construction, 1/2 HP, cETLus, NSF, CE, USDA

1 ea 115v/60/1-ph

ITEM L1 - SERVING COUNTER, MILLWORK (1 REQ'D)
Custom Fabricated - See approved manufacturer list
Refer to Plans & Elevations for Final Details

ITEM L2 - HOT / COLD FOOD WELL UNIT, DROP-IN, ELECTRIC (3 REQ'D)
Wells Model HRCP-7300 Dimensions: 25.13(h) x 46.5(w) x 27.13(d)
Hot/Cold Drop In Unit, 3-pan size, single tank with switch for hot or cold operation with self-contained refr., automatic water fill, includes (2) pan dividers, R404a, (COLD) 1/3 HP, 115v/60/1-ph, 5.6 amps, (HOT) 208/240v/60/1-ph, 14.4-16.7 amps, direct, NSF, cULus

3 ea Note: Must specify voltage and phase
3 ea Warranty: 1-year parts and labor, standard

Approved Alternate – Duke – Model # CP3-SB-DC-D

ITEM L2.1 - FOOD SHEILD, ISLAND STYLE (3 REQ'D)
Adjustaguard® Sneeze Guard, self-service/full-service, island layout, 22"H posts, 1"OD with brushed stainless steel finish, 3/8" tempered glass panels (1/4" end panels) with polished edges & 1" radius corners, NSF, cULus

Refer to factory shop drawings for final details

Approved Alternate – Duke – Model # BGA1-60-DS-GF-L

ITEM L3 - HEATED SHELF FOOD WARMER (1 REQ'D)
Hatco Model GRSBF-24-I Dimensions: 2.25(h) x 25.5(w) x 22(d)
Glo-Ray® Built In Heated Shelf with Flush Top, 25-1/2" x 17" surface area, hardcoat aluminum top, control thermostat, illuminated on/off switch & mounting bracket, 420 watts, NSF, CE, cUL, UL, UL EPH Classified, CSA

1 ea NOTE: Sale of this product must comply with Hatco's Minimum Resale Price Policy; consult order acknowledgement for details
1 ea NOTE: Includes 24/7 parts & service assistance, call 800-558-0607
1 ea 1-Yr Warranty on Blanket Heating Elements against burnout, standard
1 ea 120v/60/1-ph, 420 watts, 3.5 amps, NEMA 5-15P (domestic voltage), standard
1 ea NOTE: Recommended for use in metallic countertop, verify that the material is suitable for temperatures up to 200-degree F
1 ea Thermostat control with lhted rocker switch (available at time of purchase only), standard

ITEM L5 - HOT FOOD WELL UNIT, DROP-IN, ELECTRIC (2 REQ'D)
Wells Model SS-10TDUI Dimensions: 8.75(h) x 12(w) x 12(d)
Food Warmer, top-mount, built-in, electric, for 11-quart round insert, drain, wet/dry operation, thermostatic control, fully insulated, stainless steel construction, Wellslok, cULus, NSF

2 ea Limited 1 year parts & 1 year labor warranty, standard
2 ea 120v/60/1-ph, 825 watts, direct

ITEM L5.1 - SNEEZE GUARD, PORTABLE (1 REQ'D)
BSI Model Custom EA-101A - Size Per Drawings BQ789335
Construction & Materials**:** Custom stainless steel 1" square posts, Matte black finish.
3/8" tempered glass front panels and top shelf with square corners.
Incorporate BSI Patented Helios HEAT/LED light. Infinite controls and on/off switches mounted remotely in counter apron.
Manufactured to meet current NSF and UL standards for food shields including end panels and bear appropriate insignia.

Approved Alternate – Duke – Model # BGA1-74-SS-GF-L

ITEM L6 - CONVEYOR TOASTER (1 REQ'D)
Hatco Model TQ3-500H Dimensions: 17.13(h) x 14.7(w) x 20.62(d)
Toast-Qwik® Conveyor Toaster, countertop design, horizontal conveyor, touchscreen controls, (12) programmable recipes, all bread types toaster, approximately 7-8 slices/min capacity, USB, power save mode, toast delivery rack, 3" opening height, cULus, UL EPH Classified, CE

1 ea NOTE: Sale of this product must comply with Hatco's Minimum Resale Price Policy; consult order acknowledgement for details
1 ea NOTE: Includes 24/7 parts & service assistance, call 800-558-0607
1 ea One-year on-site parts & labor warranty, plus one additional year parts only warranty on all Toast-Qwik metal sheathed elements
1 ea 208v/50/60/1-ph, 2220 watts, 10.7 amps, NEMA 6-15P, standard
1 ea Model STANDARD Black side panels, standard

ITEM L7 - SPEEDELHT SANDWICH PRESS (1 REQ'D)
Electrolux Professional Model 603940 Dimensions: 24.81(h) x 14.19(w) x 29.56(d)
SpeeDelht Sandwich Press, electric, flexible adjustable top ribbed contact plate, 3-cooking technologies (contact, infrared radiation & microwave), digital display, (8) programs (4 pre-loaded), USB & wi-fi connections, dark grey, includes: glass saver (653527), brush (653623), spatula (653625), stainless steel feet (653791), spacer ventilation kit (653800) teflon sheets (653795), reusable teflon tray (9R0120) & detergent (0S2292), 5.0kW, 208v/60/1-ph, cETLus, ETL-Sanitation (Note: SpeeDelht is a hoodless equipment EPA 202 certified. Not required to be under a type 1 ventilation hood)

2 ea The following are included in the purchase of Electrolux Professional - SPEEDELHT units.
Start-up performed by a Factory Authorized Agent
Standard Warranty: 2 years parts & 1 year labor (Warranty activated upon completion of mandatory Factory Authorized Agent start-up)
Performance checks are included 3 months after mandatory Electrolux authorized service partner start-up
Please contact Electrolux to schedule all of the above 1-866-449-4200

ITEM L10 - SERVING COUNTER, MILLWORK (1 REQ'D)
Custom Fabricated - See approved manufacturer list
Refer to Plans & Elevations for Final Details

ITEM L11 - SNEEZE GUARD, STATIONARY (1 REQ'D)
BSI Model Custom EA-101A - Size Per Drawings BQ789335
Construction & Materials**:** Custom stainless steel 1” square posts, Matte black finish.
3/8" tempered glass front panels and top shelf with square corners.
Incorporate BSI Patented Helios LED light. Infinite controls and on/off switches mounted remotely in counter apron.
Manufactured to meet current NSF and UL standards for food shields including end panels and bear appropriate insignia.

Approved Alternate – Duke – Model # BGA1-60-SS-GF-L

ITEM L15 - SNEEZE GUARD, PORTABLE (3 REQ'D)
BSI Model Custom EA-100 - Size Per Drawings BQ789335
Custom stainless steel 1” square posts, Matte black finish. 3/8" tempered glass front panels
Manufactured to meet current NSF and UL standards for food shields including end panels and bear appropriate insignia.

ITEM L17 - SERVING COUNTER, MILLWORK (1 REQ'D)
Custom Fabricated - See approved manufacturer list
Refer to Plans & Elevations for Final Details

PART 4 - EXECUTION

4.1 GENERAL

A. Review all drawings pertaining to the food facilities and food facilities areas, including the utility load information prepared by the Consultant. Provide all equipment in accordance with the requirements of these documents (i.e., voltage characteristics, kw loads, special valves, etc.).

B. Notify the Consultant and Owner of any discrepancies between plans and specifications and actual conditions on the job before fabrication of equipment.

C. KEC. review of job conditions: The KEC shall visit the job site to field check actual wall dimensions and roughing-in and be responsible for furnishing, fabricating, and installing the equipment in accordance with the available space and utility services as they exist on the job site.

D. Check all door openings, passageways, elevators, etc., to be sure that the equipment can be conveyed to its proper location within the building and, if necessary, check with the General Contractor regarding the possibility of holding wall erection, placement of doorjambs, windows, etc., for the purpose of moving the equipment to its proper location. Any removal and rebuilding of walls, partitions, door jambs, etc., necessary to place the equipment or, if caused by incorrect information on the Contractor's drawings, shall be done at the expense of the Contractor, at no additional cost to the Owner.

E. Ensure equipment accurately fits the space as it exists and conforms to actual field dimensions on the job. Any changes required after fabrication has been started shall be made at no additional cost to the Owner.

F. Contractor shall review drawings and physically check the location and utility size of all "rough ins" at the job site for compatibility with the equipment being installed before finished floors, walls, and/or ceilings are in place. KEC shall take full responsibility for coordination of rough-ins. If rough ins have been completed by others, Contractor shall review same, note any missing or problem areas, shall so advise Consultant, and shall coordinate corrections or shall adjust his equipment to suit conditions.

G. Provide all necessary appurtenances to accommodate plumbing, electrical, and refreration, etc., rough-in as shown on utility load information; for example, an S.R. (single receptacle) connection

shown on the plan requires that the appropriate grounded cord and plug be provided to fit the receptacle as part of the equipment item to which the connection will be made.

H. Where portions of an item pass through masonry, walls, or partitions, provide complete installation of the item, including trim, field welding, dimensions, and coordinate all other work being performed relative to the item being installed.

I. All equipment, such as pass-through refrigerators and warmers, which pass through a wall where one side is exposed to public view shall be provided and installed with the operating controls located on the kitchen or working side of the wall. All equipment such as coffee urns, which are located on or in a counter having a pick-upside and a working side, shall be provided and installed with the operating controls facing the working side of the counter.

4.2 DELIVERY

A. All food service equipment shall be delivered to the job site protected from weather, vandalism and/or loss, and placed within the building. After delivery into the building, assembled and set in place, all responsibility for loss and/or damage to the food service equipment prior to final acceptance by the Owner shall rest with the Contractor.

B. Recognizing that other building trades tend to damage table and equipment tops by standing upon them to reach ceiling areas or using these surfaces for tool storage, the Food Service Equipment Contractor is encouraged to temporarily protect these surfaces from damage by the use of cardboard, plastic or similar materials, as well as posting notices warning against this damage.

C. Any items lost or damaged shall be immediately replaced or repaired to a new condition at no cost to the Owner, and to the satisfaction of the Consultant and Owner.

D. Coordination with General Contractor: The KEC shall coordinate all food service equipment delivery and installation activities with the General Contractor, avoiding all interference with the work of the G.C.

E. The KEC shall review the construction schedule and shall notify the Owner and G.C. of required lead times and Order/Approval dates for all equipment. Additional costs resulting from special handling or air shipment of equipment shall be paid by the KEC unless delays in ordering are unavoidable and the result of actions by the Owner.

4.3 WARRANTIES

A. Guarantee all equipment furnished under this Section for a minimum period of one year from the date of First Day of Business (FDOB), covering defective materials, design, and workmanship. See individual equipment descriptions for specific warranties that may exceed one year.

B. Upon receipt of notice of failure of any part of the warranted equipment during the warranty period, the affected part or parts shall be replaced promptly and at the expense of the food service equipment contractor.

C. Until the time replacement equipment is installed, the Owner shall have full use of the defective equipment.

D. Warranty shall include installation, start-up and one-year free service for all self-contained refrigeration equipment with evidence of manufacturer's one year Warranty on the entire cabinet and additional four-year Warranty on any sealed compressor motor assembly except for labor.

E. Warranty documents shall be provided to Owner at project completion.

END OF SECTION 114000

SECTION 118129 – FACILITY FALL PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rooftop fall protection system for rooftop maintenance including but not limited to anchors, clamps, and base plates as required.

B. Related Requirements:

1. Section 133419 “Metal Building Systems” for standing seam metal roof, and coordination of required structural substrate at rooftop fall protection system anchor locations.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review required testing, inspecting, and certifying procedures.
2. Coordinate the installation of fall protection system with structural supports and roofing materials.

1.3 ACTION SUBMITTALS

A. Product Data: Manufacturer's data and product information indicating the sizes, descriptions, capacities, test certifications, and other descriptive data showing in sufficient detail that the fall protection system complies with the specified requirements.

B. Shop Drawings: For fabrication showing the complete fall protection system. Layout drawings of each system in relation to the supporting structure indicating the locations of properly labeled components.

1. Include plans, member profiles, sizes, elevations and details for anchorages and connections.
2. Show complete layout of the system in plan and elevation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. Furnish proof of installer’s certification approval by manufacturer.

B. Qualification Data: For manufacturer’s professional engineer's experience with providing engineering of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fall protection systems to include in operation and maintenance manuals.

1. Maintenance Procedures: Including parts list and maintenance requirements for all equipment.
2. Manufacturer's catalog data indicating the sizes, descriptions, capacities, test certifications, and other descriptive data showing sufficient detail that the product complies with the contract requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by the manufacturer, with at least five projects showing successful installation of similar systems in the last three years.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer’s original, unopened protective packaging.

B. Store materials in original protective packaging. Prevent soiling, physical damage or wetting.

1.8 FIELD CONDITIONS

A. Field Measurements: Perform prior to preparation of Shop Drawings and fabrication drawings to ensure required fit and dimensions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Fall protection systems shall withstand the effects of loads and stresses within limits and under conditions required by ANSI A10.32, ANSI Z359.1, and OSHA 1926.502.

2.2 FALL PROTECTION SYSTEM

A. Basis-of-Design Product: Subject to compliance with requirements, provide Guardian Fall Protection; Custom CB-Single Point Anchor System, or approved equal.

1. System includes manufacturer's engineered rooftop fall protection system for rooftop maintenance including but not limited to anchors, clamps, and base plates as required.

B. Components:

1. Anchors: Minimum 5/8-inch diameter galvanized steel U-bar; minimum tensile strength Fy = 50 KSI.
2. Clamps: Designed for installation on standing seam panels with horizontal, single-folded seams.

a. Basis-of-Design Product: S-5-H90 Clamp.

3. Base Plate: Minimum 20 x 18 x 3/8-inch ASTM A36 galvanized steel base plate.
4. Fasteners: Non-corrosive; size and configuration engineered by manufacturer and indicated on shop drawings.

2.3 FABRICATION

A. Fabricate anchoring devices as recommended by the manufacturer to provide adequate support for intended use.

B. Welding: AWS structural specification D1.1 by certified welders.

C. Fabricate joints in a manner to discourage water accumulation.

D. Finishes:

1. Galvanized Steel: Finish in accordance with Section 099600 "High-Performance Coatings," color to match standing seam metal roof.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate location of fall protection system indicated to be attached to standing seam roofing system and furnish anchoring devices with templates and diagrams.

3.3 INSTALLATION

A. Install in accordance with approved shop drawings and manufacturer’s instructions. Install fall protection system by manufacturer's authorized, trained, and certified personnel.

B. Install anchorages and fasteners in accordance with manufacturer’s recommendations and instructions to obtain the allowable working loads published in the product literature and instructions and in accordance with this specification.

C. Exposed work shall be true to line and level with accurate angles, surfaces and with straight square edges. Coordinate anchorage system with supporting structure.

D. Do not load or stress system until materials and fasteners are properly installed and ready for service.

E. Do not use until trained in the use of the system.

3.4 FIELD QUALITY CONTROL

A. Provide manufacturer's certified installer to inspect installed fall protection system.

3.5 CLEANING

A. Clean components of any deleterious coatings or compounds.

B. Remove loose materials, crating, and packing materials from site.

3.6 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate operation of system to Owner's personnel.

1. Briefly describe function, operation, and maintenance of each component.

B. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide training at the installation site.
3. Training to take place at the completion of the installation.

END OF SECTION 118129

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manually operated, single-roller shades.
2. Motor-operated, double-roller shades.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
3. Section 079200 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shade band materials, their orientation to rollers, and their seam and batten locations.

1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified, 10 inches long.

D. Product Schedule: For roller shades. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of shade band material.

C. Product Test Reports: For each type of shade band material, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Mockups: Build in-place mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of First Day of Business (FDOB).

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED, SINGLE-ROLLER SHADES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Draper Clutch-Operated FlexShade, or approved equal.

B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

1. Bead Chains: Stainless steel.

a. Loop Length: Full length of roller shade.
b. Limit Stops: Provide upper and lower ball stops.
c. Chain-Retainer Type: Clip, jamb mount.

2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.

a. Provide for shade bands that weigh more than 10 lb. or for shades as recommended by manufacturer, whichever criterion is more stringent.

C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shade bands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shade bands for service.

1. Roller Drive-End Location: As indicated on Drawings.
2. Direction of Shade band Roll: Regular, from back (exterior face) of roller.
3. Shade band-to-Roller Attachment: Adhesive strip Removable spline fitting into integral channel in tube Insert description.

D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

E. Shade bands:

1. Shade band Material DR-2: Subject to compliance with requirements, provide products specified on the Finish Schedule.
2. Shade band Bottom (Hem) Bar: Steel or extruded aluminum.

a. Type: Enclosed in sealed pocket of shade band material.

F. Installation Accessories:

1. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.

a. Height: Manufacturer's standard height required to enclose roller and shade band assembly when shade is fully open.

2. Endcap Covers: To cover exposed endcaps.
3. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shade band guides or other means of aligning shade bands with channels at tops.

4. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
5. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 MOTOR-OPERATED, DOUBLE-ROLLER SHADES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Draper Dual Roller Motorized FlexShade, or approved equal.

B. Motorized Operating Systems: Provide factory-assembled, shade-operator systems of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Draper Inc.; IntelliFlex I/O, or approved equal.
2. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Electric Motor: Manufacturer's standard tubular, enclosed in rollers.

    a. Electrical Characteristics: 120-V ac, 60 HZ, 3-wire.
    b. Rated Current: 1.0 amps.
    c. Speed: 28 RPM.
    d. Sound Level: 42 dBA.
    e. Maximum Total Shade Width: As required to operate roller shades indicated.
    f. Maximum Shade Drop: As required to operate roller shades indicated.
    g. Maximum Weight Capacity: As required to operate roller shades indicated.

4. Network Devices:

    a. Network Device Connector: Connects devices into a network and distributes power and communications between devices.

        1) Provide one network device connector for each motor and network device.

    b. A\V Gateway: Used to integrate with third party control systems.

        1) Single entry point must support RS-232 and RS-485 and contain at least 6 contact closure inputs, low voltage trigger, and IR receiver input.
        2) LCD display allows for commissioning of serial groups.

    c. Contact Closure Interface: Allows up to 6 contact closure inputs to be connected to the network. These are grouped into 3 sets of Up/Down signals, each of which can control any number of shades on the network.

        1) Configuration must be done using onboard programming buttons, without rewiring or the use of external configuration devices.

2) Power is provided through the network using a single Ethernet cable for power and communication.

d. Sensor/Schedule Interface: Allows up to 4 sensors to be added to the network.

1) Must include built-in support for brightness, wind, and precipitation sensors, and pyranometers.
2) Must support up to 8 scheduled override events.
3) Configuration must be done using on-board buttons and LCD display. Supports 0-10V, 4-20mA, photodiode and pulse sensors.
4) External power input for sensors provides support for any sensor power requirements.
5) SSI Transformer: Provide when adding third party sensors to the network.

e. Sensor Interface with Automated Glare Control: Allows up to 4 sensors to be added to the network.

1) Includes built-in support for brightness, wind and precipitation sensors as well as pyranometers. Also provided support for up to 8 scheduled override events.
2) Configuration is done using on-board buttons and LCD display.
3) Supports 0-10V, 4-20mA, photodiode and pulse sensors.
4) Configuration using built-in buttons and LCD display. Scheduled events can be configured to run on any combination of days of the week.
5) External power input for sensors provides support for any sensor power requirements.

f. Central Network Controller. Touchscreen device to add advanced functionality to a network, and also acts as a router between the control network and a building IP network.

1) Graphical user interfaces on local touchscreen as and remote access web interfaces.
2) Automated glare control and scheduling.
3) BACnet/IP integration. Interface to monitor and override network devices. Allows logging of shade movements, sensor readings, and user overrides.
4) Input power: Micro USB.

g. IP Gateway: For connecting a network of devices to an IP network.

1) Built-in two port network switch for connecting directly to a building network.
2) Can be daisy chained to other IPGs to form a stand-alone network for access to all connected devices.
3) Each IPG is a BACnet/IP device. Configuration is done using the built-in buttons and display.

5. Input Devices:

a. Single Zone Wall Switch. Allows user to move roller shades to any position with a single touch.

1) Swipe gestures must be recognized to move shades to fully open or closed positions.
2) Power provided through network using a single Ethernet cable for power and communication.
3) Switch shall be capable of controlling any number of shades on the network using onboard programming buttons without rewiring or the use of external configuration devices.
4) Must allow unlimited number of preset alignment positions. Push button switches not permitted.

b. Dual Zone Wall Switch. Allows user to control two independent zones of roller shades, moving them to any position with a single touch.

1) Swipe gestures must also be recognized to move shades to fully open or closed positions.
2) Power for switch must be provided through the network using a single Ethernet cable for power and communication.
3) Each zone must be configured to control any number of shades on the network using the onboard programming buttons, without rewiring or the use of external configuration devices.
4) Unlimited number of preset alignment positions. Push button switches not permitted.

C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shade bands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shades for service.

1. Double-Roller Mounting Configuration: Offset, outside shade over and inside shade under.
2. Inside Roller:

a. Drive-End Location: As indicated on Drawings.
b. Direction of Shade band Roll: Regular, from back (exterior face) of roller.

3. Outside Roller:

a. Drive-End Location: As indicated on Drawings.
b. Direction of Shade band Roll: Regular, from back (exterior face) of roller.

4. Shade band-to-Roller Attachment: Adhesive strip.

D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller mounting configuration, roller assemblies, operating mechanisms, installation accessories, and installation locations and conditions indicated.

E. Inside Shade bands:

1. Shade band Material DR-2: Subject to compliance with requirements, provide products specified on the Finish Schedule.
2. Shade band Bottom (Hem) Bar: Steel or extruded aluminum.

    a. Type: Enclosed in sealed pocket of shade band material.

F. Outside Shade bands:

1. Shade band Material DR-3: Subject to compliance with requirements, provide products specified on the Finish Schedule.
2. Shade band Bottom (Hem) Bar: Steel or extruded aluminum.

    a. Type: Enclosed in sealed pocket of shade band material.

G. Installation Accessories:

1. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.

    a. Height: Manufacturer's standard height required to enclose roller and shade band assembly when shade is fully open.

2. Endcap Covers: To cover exposed endcaps.
3. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shade band guides or other means of aligning shade bands with channels at tops.
4. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
5. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.4 SHADE BAND MATERIALS

A. Shade band Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric DR-2: Subject to compliance with requirements, provide products specified on the Finish Schedule.

C. Light-Blocking Fabric DR-3: Subject to compliance with requirements, provide products specified on the Finish Schedule.

2.5 ROLLER SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:

1. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

C. Shadeband Fabrication: Fabricate shadebands without battens or seams.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, locations of connections to building electrical system, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

B. Electrical Connections: Connect motor-operated roller shades to building electrical system.

C. Roller Shade Locations: As indicated on Drawings.

3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of First Day of Business (FDOB).

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of First Day of Business (FDOB).

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION 122413

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid surface material countertops.
2. Solid surface material backsplashes.
3. Solid surface material end splashes.
4. Solid surface material apron fronts.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 055000 “Metal Fabrications” for counter support brackets.

1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials.

B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

1. Show locations and details of joints.
2. Show direction of directional pattern, if any.

C. Samples for Initial Selection: For each type of material exposed to view.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of countertops.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements before countertop fabrication is complete.

1.7 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ISFA 2-01.

1. Basis-of-Design Product (SS-1, SS-2): Subject to compliance with requirements, provide products specified on the Finish Schedule

B. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 FABRICATION

A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."

1. Grade: Premium.

B. Configuration:

1. Front: Straight, slightly eased at top.
2. Backsplash: Straight, slightly eased at corner.
3. End Splash: Matching backsplash.

C. Countertops:

1. 3/4-inch- thick, solid surface material with front edge built up with same material.

D. Backsplashes: 3/4-inch- thick, solid surface material.

E. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

1. Fabricate with loose backsplashes for field assembly.

F. Joints:

1. Fabricate countertops in sections for joining in field.

a. Joint Locations: Not within 18 inches of a sink or cooktop and not where a countertop section less than 36 inches long would result, unless unavoidable.
b. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.

G. Cutouts and Holes:

1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.

2. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by solid surface material manufacturer.

B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.

B. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.

C. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

D. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

1. Install metal splines in kerfs in countertop edges at joints where indicated. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.

E. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.

F. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.

G. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

H. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

SECTION 123661.19 - QUARTZ AGGLOMERATE COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Quartz agglomerate countertops.
2. Quartz agglomerate backsplashes.
3. Quartz agglomerate end splashes.
4. Quartz agglomerate apron fronts and panels.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 055000 “Metal Fabrications” for counter support brackets.

1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials.

B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

1. Show locations and details of joints.
2. Show direction of directional pattern, if any.

C. Samples for Initial Selection: For each type of material exposed to view.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For quartz agglomerate countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of countertops.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements before countertop fabrication is complete.

1.7 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS

A. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of polymers, resins, and pigment and complying with ISFA 3-01.

1. Basis-of-Design Product (QZ-1 through QZ-3): Subject to compliance with requirements, provide products specified on the Finish Schedule.

B. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 FABRICATION

A. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the AWI/AWMAC/WI's "Architectural Woodwork Standards."

1. Grade: Premium.

B. Configuration:

1. Front: Straight, slightly eased at top.
2. Backsplash: Straight, slightly eased at corner.
3. End Splash: Matching backsplash.

C. Countertops: 3/4-inch- thick, quartz agglomerate with front edge built up with same material.

D. Backsplashes: 3/4-inch- thick, quartz agglomerate.

E. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

1. Fabricate with loose backsplashes for field assembly.

F. Joints:

1. Fabricate countertops in sections for joining in field.

a. Joint Locations: Not within 18 inches of a sink or cooktop and not where a countertop section less than 36 inches long would result, unless unavoidable.
b. Joint Type, Bonded: 1/32 inch or less in width.

G. Cutouts and Holes:

1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.

2. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by quartz agglomerate manufacturer.

B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive quartz agglomerate countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.

B. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.

C. Secure countertops to subtops with adhesive according to quartz agglomerate manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

D. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

1. Install metal splines in kerfs in countertop edges at joints where indicated. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned, and joints are of specified width.

E. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.

F. Install aprons and panels to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.

G. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

H. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.19

SECTION 133419 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel framing.
2. Metal roof panels.
3. Accessories.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”
2. Section 072100 "Thermal Insulation" for thermal insulation and moisture control system for metal buildings.
3. Section 074213.19 "Insulated Metal Wall Panels" for exterior wall cladding.
4. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface.
5. Section 081113 "Hollow Metal Doors and Frames" for pedestrian doors in metal building systems.
6. Section 084113 "Aluminum-Framed Entrances and Storefront" for aluminum-framed entrances, storefronts, and punched openings.
7. Section 099123 "Interior Painting" for factory prime compatibility with field applied coatings.
8. Section 118129 “Facility Fall Protection” for rooftop fall protection system.

1.2 DEFINITIONS

A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in standards referenced by this Section.

1.3 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to metal building systems including, but not limited to, the following:

   a. Condition of foundations and other preparatory work performed by other trades.
   b. Structural load limitations.
   c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.
   d. Required tests, inspections, and certifications.
   e. Unfavorable weather and forecasted weather conditions and impact on construction schedule.

2. Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:

   a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.
   b. Structural limitations of purlins and rafters during and after roofing.
   c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
   d. Temporary protection requirements for metal roof panel assembly during and after installation.
   e. Roof observation and repair after metal roof panel installation.

3. Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:

   a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.
   b. Structural limitations of girts and columns during and after wall panel installation.
   c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
   d. Temporary protection requirements for metal wall panel assembly during and after installation.
   e. Wall observation and repair after metal wall panel installation.

1.5 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Indicate components by others. Include full building plan, elevations, sections, details, and the following:

1. Anchor-Rod Plans: Submit anchor-rod plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor rods

required to attach metal building to foundation. Indicate column reactions at each location.

2. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.

    a. Include all framing, subjambs and strapping required for installation of rooftop fall protection system specified in Section 118129 “Facility Fall Protection.”

3. Metal Roof and Wall Panel Layout Drawings: Show layouts of panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, clip spacing, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.
4. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:

    a. Flashing and trim.
    b. Gutters.
    c. Downspouts.

C. Samples for Initial Selection: For units with factory-applied finishes.

D. Samples for Verification: For the following products:

1. Panels: Nominal 12 inches long by actual panel width. Include fasteners, closures, and other exposed panel accessories.
2. Flashing and Trim: Nominal 12 inches long. Include fasteners and other exposed accessories.
3. Accessories: Nominal 12-inch- long Samples for each type of accessory.

E. Analysis Data: For metal building systems, include analysis data indicating compliance with performance requirements and design data signed and sealed by the metal building systems’ qualified professional engineer, licensed in the state of the Project, responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For erector and manufacturer.

B. Welding certificates.

C. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

1. Name and location of Project.
2. Order number.
3. Name of manufacturer.
4. Name of Contractor.
5. Building dimensions including width, length, height, and roof slope.

6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
7. Governing building code and year of edition.
8. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
10. Building-Use Category: Indicate category of building use and its effect on load importance factors.

D. Erector Certificates: For qualified erectors, from manufacturer.

E. Material Test Reports: For each of the following products:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shop primers.
5. Nonshrink grout.

F. Source quality-control reports.

G. Field quality-control reports.

H. Surveys: Show final elevations and locations of major members. Indicate discrepancies between actual installation and the Contract Documents. Have surveyor who performed surveys certify their accuracy.

I. Sample Warranties: For special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panel finishes to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Accreditation: Manufacturer's facility accredited according to IAS AC472, "Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems."
2. Engineering Responsibility: Preparation of comprehensive engineering analysis and Shop Drawings by the metal building systems' professional engineer who is legally qualified to practice in jurisdiction where Project is located.

B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with panel installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of First Day of Business (FDOB).

B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.

1. Warranty Period: 20 years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide a pre-engineered metal building systems from Nucor Building Systems.

B. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

2.2 SYSTEM DESCRIPTION

A. Provide a complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.

B. Primary-Frame Type:

1. Rigid Modular: Solid-member, structural-framing system with interior columns.

C. End-Wall Framing:

1. Engineer end walls to be expandable. Provide primary frame, capable of supporting full-bay design loads, and end-wall columns.

D. Secondary-Frame Type: Manufacturer's standard purlins and joists and exterior-framed (bypass) girts.

E. Eave Height: Manufacturer's standard height, as indicated by nominal height on Drawings.

F. Bay Spacing: As indicated on Drawings.

G. Roof Slope: As indicated on Drawings.

H. Roof System: Manufacturer's standard standing-seam, vertical-rib, metal roof panels.

I. Exterior Wall System: Refer to Section 074213.19 "Insulated Metal Wall Panels".

2.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Metal building systems to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."

1. Design Loads: Refer to Drawing S0.1 General Structural Notes.

B. Seismic Performance: Metal building system to withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Seismic Design Criteria: Refer to Drawing S0.1 General Structural Notes.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

D. Fire-Resistance Ratings: Where assemblies are indicated to have a fire-resistance rating, provide metal panel assemblies identical to those of assemblies tested for fire resistance per ASTM E119 or ASTM E108 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory," FM Global's "Approval Guide," or from the listings of another qualified testing agency.

E. Fire Propagation Characteristics: Exterior wall assemblies containing foam plastics pass NFPA 285 fire test.

F. Structural Performance for Metal Roof Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Design Criteria: Refer to Drawing S0.1 General Structural Notes.

G. Air Infiltration for Metal Roof Panels: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E1680 or ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

H. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

I. Water Penetration for Metal Wall Panels: Refer to Section 074213.19 "Insulated Metal Wall Panels".

J. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

K. Thermal Performance for Opaque Elements: Refer to Drawing CP0.0 Code Summary.

2.4 STRUCTURAL-STEEL FRAMING

A. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings."

B. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

C. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.

D. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

    a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect.

2. Rigid Modular Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
3. Long-Bay Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
4. Exterior Column: Tapered.
5. Rafter: Uniform depth.

E. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:

1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet.
2. End-Wall Rafters: C-shaped, cold-formed, structural-steel sheet; or I-shaped sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.

F. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from metallic-coated steel sheet to comply with the following:

1. Purlins:

    a. C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- wide flanges.

        1) Depth: As needed to comply with system performance requirements.

2. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch- wide flanges.

    a. Depth: As required to comply with system performance requirements.

3. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
4. Flange Bracing: Minimum 2-by-2-by-1/8-inch structural-steel angles or 1-inch- diameter, cold-formed structural tubing to stiffen primary-frame flanges.
5. Sag Bracing: Minimum 1-by-1-by-1/8-inch structural-steel angles.
6. Base or Sill Angles: Manufacturer's standard base angle, minimum 3-by-2-inch, fabricated from zinc-coated (galvanized) steel sheet.
7. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
8. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
9. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

G. Bracing: Provide adjustable wind bracing using any method as follows:

1. Rods: ASTM A36/A36M; ASTM A572/A572M, Grade 50; or ASTM A529/A529M, Grade 50; minimum 1/2-inch- diameter steel; threaded full length or threaded a minimum of 6 inches at each end.
2. Cable: ASTM A475, minimum 1/4-inch- diameter, extra-high-strength grade, Class B, zinc-coated, seven-strand steel; with threaded end anchors.
3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
4. Rigid Portal Frames: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
5. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.

H. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.

I. Materials:

1. W-Shapes: ASTM A992/A992M; ASTM A572/A572M, Grade 50 or 55; or ASTM A529/A529M, Grade 50 or 55.
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55; or ASTM A529/A529M, Grade 50 or 55.
3. Plate and Bar: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55; or ASTM A529/A529M, Grade 50 or 55.
4. Steel Pipe: ASTM A53/A53M, Type E or S, Grade B.
5. Cold-Formed Hollow Structural Sections: ASTM A500, Grade B or C, structural tubing.

6. Structural-Steel Sheet: Hot-rolled, ASTM A1011/A1011M, Structural Steel (SS), Grades 30 through 55, or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70; or cold-rolled, ASTM A1008/A1008M, Structural Steel (SS), Grades 25 through 80, or HSLAS, Grades 45 through 70.
7. Metallic-Coated Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80, or HSLAS or HSLAS-F, Grades 50 through 80; with G60 coating designation; mill phosphatized.
8. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80, or HSLAS or HSLAS-F, Grades 50 through 80; with G90 coating designation.
    b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, SS, Grade 50 or 80; with Class AZ50 coating.

9. Joist Girders: Manufactured according to "Standard Specifications for Joist Girders," in SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for primary framing.
10. Non-High-Strength Bolts, Nuts, and Washers: ASTM A307, Grade A, carbon-steel, hex-head bolts; ASTM A563 carbon-steel hex nuts; and ASTM F844 plain (flat) steel washers.

    a. Finish: Plain.

11. High-Strength Bolts, Nuts, and Washers, Grade A325: ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

    a. Finish: Hot-dip zinc coating, ASTM F2329, Class C.

12. High-Strength Bolts, Nuts, and Washers, Grade A490: ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
13. Headed Anchor Rods: ASTM F1554, Grade 36.

    a. Configuration: Straight.
    b. Nuts: ASTM A563 heavy-hex carbon steel.
    c. Plate Washers: ASTM A36/A36M carbon steel.
    d. Washers: ASTM F436 hardened carbon steel.
    e. Finish: Plain.

14. Threaded Rods: ASTM A36/A36M.

    a. Nuts: ASTM A563 heavy-hex carbon steel.
    b. Washers: ASTM F436 hardened carbon steel.
    c. Finish: Plain.

J. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.

1. Clean and prepare in accordance with SSPC-SP2.
2. Coat with primer approved in writing by finish coating system manufacturer. Apply primer to primary framing to a minimum dry film thickness of 1 mil.

a. Factory prime only secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil on each side.

2.5 METAL ROOF PANELS

A. Standing-Seam, Vertical-Rib, Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 24 gauge (0.0222 inch) nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Exterior Finish: Two-coat fluoropolymer.
b. Color: As selected by Architect from manufacturer's full range.

2. Clips: Two-piece floating to accommodate thermal movement.
3. Joint Type: Mechanically seamed.
4. Panel Coverage: 16 inches.
5. Panel Height: 2 inches.
6. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.6 FOAMED-INSULATION-CORE METAL WALL PANELS

A. Refer to Section 074213.19 "Insulated Metal Wall Panels".

2.7 THERMAL INSULATION

A. Refer to Section 072100 "Thermal Insulation" for thermal insulation and moisture control system for metal buildings.

2.8 DOORS AND FRAMES

A. Refer to Section 081113 "Hollow Metal Doors and Frames” and Section 084113 "Aluminum-Framed Entrances and Storefronts".

2.9 FACILITY FALL PROTECTION

A. Refer to Section 118129 "Facility Fall Protection" rooftop fall protection system.

2.10 SNOW GUARDS

A. Refer to Section 077253 "Snow Guards" for standing-seam mounted metal snow guards.

2.11 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
2. Clips: Manufacturer's standard, formed from stainless steel sheet, designed to withstand negative-load requirements.
3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from stainless steel sheet or nylon-coated aluminum sheet.
4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch standoff; fabricated from extruded polystyrene.

C. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match adjacent metal panels.

1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.

2. Opening Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.

D. Gutters: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."

1. Gutter Supports: Fabricated from same material and finish as gutters.
2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

E. Downspouts: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot- long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters.

F. Materials:

1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
2. Fasteners for Metal Roof Panels:

    a. Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless steel or zinc-alloy-steel hex washer head, with EPDM washer under heads of fasteners bearing on weather side of metal panels.

3. Fasteners for Metal Wall Panels: Refer to Section 074213.19 "Insulated Metal Wall Panels".
4. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
5. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
6. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
7. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
8. Metal Panel Sealants:

    a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
    b. Joint Sealant: ASTM C920; one-part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.12 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members to be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

1. Make shop connections by welding or by using high-strength bolts.
2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
4. Weld clips to frames for attaching secondary framing if applicable, or punch for bolts.
5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with primer approved in writing by finish coating system manufacturer after fabrication.

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

1. Make shop connections by welding or by using non-high-strength bolts.
2. Shop Priming: Prepare only uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with primer approved in writing by finish coating system manufacturer after fabrication.

E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

2.13 SOURCE QUALITY CONTROL

A. Special Inspection: Owner will engage a qualified special inspector to perform source quality control inspections and to submit reports.

1. Accredited Manufacturers: Special inspections will not be required if fabrication is performed by an IAS AC472-accredited manufacturer approved by authorities having jurisdiction to perform such Work without special inspection.

    a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed according to Contract requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.

1. Engage land surveyor to perform surveying.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system according to manufacturer's written instructions and drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.

    a. Joint Type: Snug tightened or pretensioned as required by manufacturer.

G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and windows.
3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

H. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.
2. Locate interior end-bay bracing only where indicated.

I. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

J. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 METAL PANEL INSTALLATION, GENERAL

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.

1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.

D. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports unless otherwise indicated.
3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Locate metal panel splices over structural supports with end laps in alignment.
6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

E. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

F. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

G. Installation Tolerances: Shim and align metal wall panels within installed tolerance of 1/4 inch in 20 feet, noncumulative; level, plumb, and on location lines; and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.5 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.

B. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint, at location and spacing and with fasteners recommended by manufacturer.

3.6 METAL WALL PANEL INSTALLATION

A. Refer to Section 074213.19 "Insulated Metal Wall Panels".

3.7 THERMAL INSULATION INSTALLATION

A. Refer to Section 072100 "Thermal Insulation".

3.8 DOORS AND FRAMES INSTALLATION

A. Refer to Section 081113 "Hollow Metal Doors and Frames and Section 084113 "Aluminum-Framed Entrances and Storefronts".

3.9 FACILITY FALL PROTECTION INSTALLATION

A. Refer to Section 118129 "Facility Fall Protection" rooftop fall protection system.

3.10 SNOW GUARDS INSTALLATION

A. Refer to Section 077253 "Snow Guards" for standing-seam mounted metal snow guards.

3.11 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1-inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Tie downspouts to underground drainage system indicated.

3.12 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.

B. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.13 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Touchup Painting:

1. After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.

a. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."
b. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

D. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 133419

SECTION 133613 - FABRICATED STORM SHELTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fabricated storm shelters.
2. Accessories.

B. Related Requirements:

1. Section 017419 “Construction Waste Management and Disposal.”

1.2 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of steel embeds into foundation walls and footings. Steel embed installation, concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fabricated storm shelters including, but not limited to, the following:

a. Condition of foundations and other preparatory work performed by other trades.
b. Structural load limitations.
c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.
d. Required tests, inspections, and certifications.
e. Unfavorable weather and forecasted weather conditions and impact on construction schedule.

1.4 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Indicate components by others. Include full plan, elevations, sections, details and the following:

1. Steel Embed Plans: Submit plans and templates before foundation work begins. Include locations required to attach fabricated storm shelter to foundation. Indicate reactions at each location.
2. Anchor Bolt Drawings: Layouts with bolt diameters.
3. Anchor Rod System (Bolt Pull Test) Data: Testing data by an Independent Laboratory on pull strength of anchor bolts in foundation.

C. Samples for Initial Selection: For units with factory-applied finishes.

D. Analysis Data: For fabricated storm shelters and concrete foundation, include analysis data signed and sealed by the manufacturer’s qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For erector and manufacturer.

B. Welding certificates.

C. Certification: Manufacturer certification that the building conforms to the contract documents and manufacturer's standard design procedures.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum five years’ experience in providing fabricated storm shelters similar in scope to this project.

1. Manufacturer shall be a producer Member for the NSSA
2. Engineering Responsibility: Preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in jurisdiction where Project is located.

B. Installer Qualifications: An experienced installer who specializes in work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components and other manufactured items so as not to be damaged or deformed.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when weather conditions permit fabricated storm shelters to be installed according to manufacturers' written instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Performance criteria for fabricated storm shelters is based on design criteria in FEMA 361 Second Edition/August 2008 publication and the manuals and publications listed therein, and the ASCE 7-05.

1. FEMA 361 manual and ASCE 7-05 present the information necessary for the computation of wind pressures and the loads imposed by winds on the walls, roof, windows, and doors of the fabricated storm shelter. Design walls, ceiling, floor, foundation, and all connections joining these elements to resist the pressures and loads calculated from the design wind speed without localized element failure and without separating from one another.
2. The entire fabricated storm shelter structure must resist failure from wind pressures and debris impacts. Structural elements and the building envelope must be designed to resist wind-induced loads as well as impacts from debris.

B. Resistance to Loads from Wind Pressure:

1. Determine wind pressures using ASCE 7-05 Minimum Design Loads for Buildings and Other Structures (or revisions to this standard).

    a. Pressures for the Main Wind Force Resisting System (MWFRS) are to be used for the walls, ceiling, structural attachments, and foundation system.
    b. Pressures for Components and Cladding are to be used for the door and other attachments to the exterior of the Safe Room.
    c. For computing wind pressures to be used as a service load, the wind velocity (V) shall be minimum of 250 mph (3-second peak gust).

2. Design walls, ceiling, and floor to withstand design pressures such that no element shall separate from another (such as walls to floor, ceiling to walls). Such separation shall constitute a failure of the fabricated storm shelter.
3. Fabricated storm shelter structure must resist failure from overturning, shear (sliding), and uplift from design pressures.
4. The Allowable Stress Design (ASD) method shall be used for the fabricated storm shelter design for any of the construction materials selected. Unfactored load combinations shall be used in accordance with ASCE 7-05 for allowable stress design.

    a. Because of the extreme nature of this design wind speed, other environmental loads, such as flood or earthquake loads, should not be added.

5. No importance factor shall be added to the pressure calculations because the extreme nature of the design event already accounts for critical nature of the fabricated storm shelter. Therefore, the importance factor (1) used in the design computations shall equal one. The internal gust coefficient (GCpi) shall be for buildings with no openings.
6. In the event that the roof of the fabricated storm shelter is exposed at grade, the roof of the fabricated storm shelter shall be able to resist wind pressures as determined in sections 1(a) through (e).B. Windbome Missile Impact Resistance on Safe Room Walls and Ceiling.

C. Resistance to Loads from Windborne Missile Impacts:

1. For design purposes, it is assumed that the design wind speed of 250 mph propels a 15-lb. missile horizontally at 100 mph. The design missile is a nominal 2x4 wood board, 12 feet long, weighing 15 lbs., striking the fabricated storm shelter enclosure on end 90° to the surface. The vertical missile design speed is 2/3 of the horizontal speed, or 67 mph.
2. The walls and ceiling of a fabricated storm shelter must resist perforation by the design missile such that the missile does not perforate the inside most surface of the fabricated storm shelter. Only fabricated storm shelter wall openings used for access are permitted. Windows, skylights, or other similar openings shall not be used unless they have been laboratory tested to meet the missile impact criteria of section 2(a).

    a. Note: The Wind Engineering Research Center at Texas Tech University has tested numerous materials and material combinations and should be contacted regarding performance of those materials.

D. Other Loads:

1. Assess whether an adjacent structure is a liability to the fabricated storm shelter; that is, if it poses a threat to the fabricated storm shelter from collapse. If the adjacent structure is deemed a liability, the loads imposed upon the fabricated storm shelter due to the collapse of this adjacent structure shall be considered as an additional impact load on the fabricated storm shelter.

E. Safe Room Access Doors and Door Frames:

1. The fabricated storm shelter entry doors and frames shall resist the design wind pressures for components and cladding of this criteria and the missile impact loads of FEMA 361.

    a. Only doors and their frames that can resist calculated design wind pressures and are constructed of materials tested and passed by Texas Tech WISE Research Center for missile impacts are acceptable.
    b. All doors shall have sufficient points of connection to their frame to resist design wind pressure and impact loads. Unless specifically designed for, each door shall be attached to their frame with a minimum of six points of connection.
    c. Note: See the design specifications and details for Safe Room doors in FEMA 361 publication for additional guidance.
    d. Door designs and materials of construction included in FEMA 361 publication were developed through calculations and laboratory testing at Texas Tech University.

2. The doorway shall provide a minimum clear opening width of 32 inches for wheelchair accessibility. The transition from the concrete sidewalk into the fabricated storm shelter must not exceed 1/4-inch vertical rise. If a threshold is provided, it must be wheelchair accessible.

F. Safe Room Ventilation (FEMA 361):

1. Provide forced air ventilation for the fabricated storm shelter.

a. A protective shroud or cowling, meeting the missile impact requirements of FEMA 361, must protect any ventilation openings in the fabricated storm shelter and have interior baffles to prevent debris intake.
b. The ventilation system must be capable of providing the minimum number of air changes for the fabricated storm shelter occupancy rating of 15 cubic feet per person per minute and have interior louvers to prevent insects from entering when not in use.

2. Protect all mechanical, electrical, and other equipment providing this ventilation to the same standard as the fabricated storm shelter.

G. Emergency Lighting and Lighted Exit Signs:

1. Provide emergency lighting for the fabricated storm shelter.
2. Install lighted EXIT sign over each door.

H. Safe Room Accessibility: Provide in accordance with the Americans with Disabilities Act (ADA).

2.2 SYSTEM DESCRIPTION

A. Fabricated Storm Shelter: Above-ground, pre-engineered, pre-manufactured, 1/4-inch steel plate material fabricated storm shelter with rolled rounded roof and ceiling, installed on a monolithic concrete foundation system.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Survive-A-Storm; SAS CS1056, or approved equal.

B. Metal Materials: Select materials and material yield strengths based on building design requirements.

1. Finish: Sandblasted, primed, and painted inside and outside white.

C. Framing Components: Minimum 3-inch x 3-inch angle frame ribbing on 48-inch centers, 3/8-inch x 4-inch x 4-inch angle anchor frame using 3/4-inch anchor bolts a minimum of eight (8) inches in length with bolt holes on 24 inches on center.

1. Primary Framing: Welded steel frame as required to meet the design criteria.

2. The frame shall be grounded and anchored to a cast-in-place concrete monolithic slab/foundation system that is reinforced as determined by delegated design of fabricated storm shelter.

D. Roof and Wall Panel Components:

1. Steel walls, rounded roof panels, doors and ventilation guards shall be constructed of 1/4-inch-thick steel materials, which have been tested and passed by Texas Tech WISE Research Center, to meet the design criteria.
2. Panel construction shall form a weather-tight barrier and shall be attached to the primary framework as determined by delegated design of fabricated storm shelter.

E. Doors and Door Hardware:

1. Doors shall be 6-point locking and have an additional dead bolt lock that is key operated for security.
2. Doors shall be operable with a minimum of force. Latches shall be operated with level type handles that comply with the ADAAG. The door(s) shall swing out and have a 2-inch minimum overlap and 1-inch hinge and lock materials.
3. The doorway(s) shall provide a minimum clear opening of 32 inches for wheelchair access.
4. The threshold shall comply with the ADAAG for wheelchair accessibility.

F. Seating: Single 16-inch in depth seat down both sides, maintaining wheelchair passable space. Seats and brackets are to be constructed of minimum 3/16-inch steel.

G. Photovoltaic System:

1. Provide a complete, operational photovoltaic system sized to provide power to all electrical devices and components.
2. Photovoltaic system components include but are not limited to solar panels, mounting brackets, PV switches, solar charge controller, battery backup, and inverter/charger.

H. Electrical System:

1. Provide breaker panels and mounting brackets, with a welded receptacle box for light and switch installations, mounting brackets for fluorescent lights and emergency lighting.
2. Provide a lighted EXIT sign with emergency light over each door.
3. Provide grounding at multiple locations with copper wire and grounding rods to meet national and local electric code requirements.
4. Provide conduit, wiring, breakers, and all electrical components and materials necessary for a complete, operational electrical and lighting system.

I. Ventilation:

1. Provide a powered forced air ventilation system to provide a minimum of 15 cubic feet of fresh air per person per minute.
2. At all ventilation system exterior intake/exhaust ducts, provide a protective shroud or cowling that meets the same missile impact requirements as the fabricated storm shelter.

3. At intake and exhaust ducts, provide interior baffles to prevent debris from entering into fabricated storm shelter.

2.3 ACCESSORIES

A. General: Provide accessories as standard with fabricated storm shelter manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Before installation proceeds, survey elevations and locations of concrete-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive fabricated storm shelter, with installer present, for compliance with requirements and manufacturer's tolerances.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fabricated storm shelter according to manufacturer's written instructions and drawings.

B. Do not field cut, drill, or alter structural members without written approval from manufacturer's professional engineer.

C. Set fabricated storm shelter accurately in location indicated.

1. Level and plumb fabricated storm shelter as required.

3.3 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.

B. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. Touchup Painting:

1. After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.

    a. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."
    b. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

END OF SECTION 133613

SECTION 210500 – COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aboveground piping.
2. Buried piping.
3. Escutcheons.
4. Expansions: hose and braid.
5. Mechanical couplings.
6. Pipe hangers and supports.
7. Pipe sleeves.
8. Pipe sleeve-seal systems.
9. Piping specialties.
10. Pressure gauges.

B. Related Requirements:

1. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this section.

1.2 SECTION INCLUDES

A. REFERENCE STANDARDS

B. The publications listed below form a part of this Specification to the extent referenced. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1. ASME A112.18.1 – Plumbing Supply Fittings.
2. ASME B40.100 – Pressure Gauges and Gauge Attachments.
3. ASME BPVC-IX – Boiler and Pressure Vessel Code, Section IX – Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
4. ASTM A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
5. ASTM A536 – Standard Specification for Ductile Iron Castings.
6. ASTM C592 – Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
7. ASTM E814 – Standard Test Method for Fire Tests of Penetration Firestop Systems.
8. AWWA C110/A21.10 – Ductile-Iron and Gray-Iron Fittings.
9. AWWA C111/A21.11 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
10. AWWA C606 – Grooved and Shouldered Joints.

11. NFPA 13 – Standard for the Installation of Sprinkler Systems.
12. NFPA 70 – National Electrical Code (NEC)
13. NFPA 1963 – Standard for Fire Hose Connections.
14. UL (DIR) – Online Certifications Directory.
15. UL 393 – Indicating Pressure Gauges for Fire-Protection Service.
16. UL 405 – Standard for Safety Fire Department Connection Devices.

C. Code Compliance: Comply with most current edition adopted by the Authority Having Jurisdiction (AHJ) of following:

1. International Code Council:

a. International Building Code (IBC), Standards and Amendments.
b. International Mechanical Code (IMC), Standards and Amendments.
c. International Fire Code (IFC), Standards and Amendments.
d. International Fuel Gas Code (IFGC).

2. IAMPCO Uniform Plumbing Code (UPC), Standards and Amendments.
3. NFPA 70.
4. Applicable State and local codes, laws, and ordinances.

1.3 SCOPE OF WORK – GENERAL

A. This section specifies general requirements for Fire Suppression installations and includes requirements common to more than one section of Division 21. It expands and supplements the requirements specified in sections of Division 01.

B. Provide materials, labor, transportation, tools, permits, fees, inspections, utilities, and incidentals necessary for the complete installation of Fire Suppression work indicated and described in the Contract Documents.

C. It is the intent of the Contract Documents to provide an installation complete in every respect. If additional details or special construction is required for work indicated or specified under this section of work or work specified in other sections, provide material and equipment which is usually furnished with such systems to complete the installation, whether mentioned or not.

1.4 SEQUENCE OF WORK

A. Conduct work in sequence to provide least possible interference to the activities of the Tenant, and to permit orderly transfer of activities and equipment to completed areas.

B. Work shall be substantially complete by the dates listed in Division 01 Section “Summary”.

1.5 ALTERNATES

A. Refer to Division 01 Section “Alternates” for description of alternates. Review Contract Documents for additional information.

1.6 DEFINITIONS

A. Provide: Furnish and install complete and ready for intended use.

B. Indicated: Indicated on drawings.

C. Noted: Noted on Drawings or in Specifications.

D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

E. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

F. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

G. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in shafts.

H. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.7 SAFETY OF PERSONS AND PROPERTY

A. Comply with applicable laws, ordinances, rules, and regulations of any public authority for the safety of persons and property, including requirements of the Local Department of Safety and Health (DOSH) or the Occupational Safety and Health Act (OSHA) whichever is most stringent, and Division 01 – General and Supplementary Conditions.

1.8 PERMITS AND FEES

A. Obtain and pay for required permits and fees necessary to fully complete work included in the Contract Documents.

1.9 INTENT AND INTERPRETATION

A. Drawings and Specifications supplement each other, and any details contained in one and not the other shall be included as if contained in both. Items not specifically mentioned in the specifications or noted on the drawings, but which are obviously necessary to make a complete working installation shall be included.

B. Drawings are partly diagrammatic and do not necessarily show the exact location of new piping and existing utilities, unless specifically dimensioned.

C. Riser and other diagrams are schematic only and do not necessarily show the physical arrangement of equipment. They shall not be used for obtaining quantities or linear runs of piping.

D. Grilles, fixtures, or other pieces of equipment shall be centered on windows, wall spaces, or other items, unless specifically dimensioned otherwise.

E. The location of piping shall be checked to determine that it clears openings and structural members; that it may be properly concealed; and that it clears cabinets, lights and equipment having fixed locations.

F. Mechanical drawings shall serve as working drawings for Division 21 work. Refer to the Architectural, Structural, and Electrical drawings for additional detail affecting the installation of work. Architectural drawings shall take precedence over the Mechanical drawings if any dimensional discrepancies exist.

G. The approximate location of each item is indicated on the drawings. These drawings are not intended to give complete and exact details regarding location. Exact locations are to be determined by actual measurements at the building. Not all pipe offsets are indicated on the drawings.

1.10 SUBMITTAL OF EQUIPMENT FOR APPROVAL

A. Refer to Division 01 requirements for submittal definitions, requirements, and procedures. Additional requirements are listed below.

B. Shop drawings, catalog information, and material schedules shall be submitted for approval on materials and equipment prior to ordering.

C. Submittals not meeting the following requirements will be returned for revision:

1. Provide a cover page for each item or group of items (schedule group, single fixture plus trim group, etc.).
2. Each cover page must be clearly identified with the project name, specification number and paragraph number.
3. Submittal package must be accompanied by an itemized index listing specification section, paragraph number, item, and manufacturer; larger projects will be index tabbed by specification section with index for each section.

1.11 GUARANTEE

A. Guarantee satisfactory operation of material and equipment installed under Division 21. Repair or replace any defective materials, equipment, or workmanship which may show itself within one year from the date of Substantial Completion.

1.12 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

A. Where more than one manufacturer is listed, provide products of only one manufacturer for each type of product.

B. Materials used under this Contract, unless specifically noted otherwise, shall be new and of the latest and most current model line produced by the manufacturer. Outdated “new” equipment is not acceptable.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.13 EQUIPMENT AND MATERIAL SUBSTITUTIONS

A. Throughout these Contract Documents, various materials, equipment, apparatus, etc., are specified by manufacturer, brand name, type, or catalog number. Such designation is to establish standards of desired quality and construction and shall be the basis of the bid.

B. Where more than one manufacturer is listed, and only one manufacturer’s catalog number is indicated, that standard of quality and construction shall be maintained by materials supplied by other manufacturer(s).

C. Substitutions of equipment or materials shall be made only with written prior approval. Prior approval requests must be received at least ten (10) days prior to bid date unless otherwise instructed. Refer to Division 01 Section, “Substitution Procedures” for procedures in requesting substitutions. The Tenant or Tenant’s representative shall review all substitution requests for final approval.

D. Acceptance of substitution request signifies manufacturer recognition only. No attempt has been made to check each item as to special features, capacities, or physical dimensions required by this project. Verify requirements before submitting for approval. Acceptance of exact features, sizes, capacities, etc., all of which must meet or exceed design requirements will be determined when submitted during the construction phase.

E. Substitution request must include manufacturer, specific model number, special features, physical dimensions, and capacities of proposed equipment. Verify requirements before submitting for approval.

F. The Contractor shall bear full responsibility for substituted equipment and materials, including, but not limited to:

1. Costs.
2. Available space requirements.
3. Effect on other trades.
4. Changes in electrical requirements.
5. Changes in structural requirements.

1.14 SUBMITTALS

A. See Division 01 for submittal procedures.

B. Product Data: Provide manufacturer's catalog information. Indicate valve data and ratings.

C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, and floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

D. Project Record Documents: Record actual locations of components and tag numbering.

E. Operation and Maintenance Data: Include installation instructions and spare parts lists.

1.15 QUALITY ASSURANCE

A. Comply with UL (DIR) requirements.

B. Valves: Bear UL (DIR) product listing label or marking. Provide manufacturer's name and pressure rating marked on valve body.

C. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

D. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.16 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place.

B. Provide temporary end caps and closures on piping and fittings. Maintain these in place until installation.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Sprinkler-based System:

1. Comply with NFPA 13.
2. See Section 211300.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

C. Provide system pipes, fittings, sleeves, escutcheons, seals, and other related accessories.

2.2 BURIED PIPING

A. Ductile Iron Pipe: AWWA C151/A21.51.

1. Fittings: AWWA C110/A21.10, standard thickness.
2. Joints: AWWA C111/A21.11, styrene-butadiene rubber (SBR) or vulcanized SBR gasket.
3. Mechanical Couplings: Shaped composition sealing gasket, steel bolts, nuts, and washers.

2.3 ABOVEGROUND PIPING

A. Pipe or tubing shall be metallic and meet or exceed the standards of NFPA 13.

2.4 PIPE SLEEVES

A. Vertical Piping:

1. Sleeve Length: 1 inch above finished floor.
2. Provide sealant for watertight joint.
3. Blocked Out Floor Openings: Provide 1½ inch angle set in silicon adhesive around opening.
4. Drilled Penetrations: Provide 1½ inch angle ring or square set in silicone adhesive around penetration.

B. Pipe Passing Through Below Grade Exterior Walls:

1. Zinc-coated or cast-iron pipe.
2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.

C. Clearances:

1. Provide allowance for insulated piping.
2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
3. Rated Openings: Caulked tight with firestopping material complying with ASTM E814 in accordance with Section 078413 to prevent the spread of fire, smoke, and gases.

2.5 PIPE SLEEVE-SEAL SYSTEMS

A. Modular Mechanical Seals:

1. Elastomer-based interlocking links to continuously fill annular space between pipe and wall-sleeve, wall, or casing opening.
2. Watertight seal between pipe and wall-sleeve, wall, or casing opening.
3. Size and select seal component materials in accordance with service requirements.
4. Service Requirements:

a. Underground, buried, and wet conditions.

5. Glass-reinforced plastic pressure end plates.

B. Wall Sleeve: PVC material with waterstop collar, and nailer end caps.

C. Sleeve-Forming Disk: Nonconductive plastic-based material, 3 inches thick.

D. Pipeline-Casing Seals:

1. End Seals: ⅛ inch, pull-on type, rubber or synthetic rubber based.

2.6 ESCUTCHEONS

A. Manufacturers:

1. Fire Protection Products, Inc.
2. Tyco Fire Protection Products.
3. Viking Group Inc.

B. Material:

1. Fabricate from nonferrous metal.
2. Chrome-plated.
3. Metals and Finish: Comply with ASME A112.18.1.

C. Construction:

1. One-piece for mounting on chrome-plated tubing or pipe and one-piece or split-pattern type elsewhere.
2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.7 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes ½ to 4 inches: Galvanized carbon steel, adjustable, band.

B. Hangers for Pipe Sizes Over 4 inches: Carbon steel, adjustable, clevis.

C. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.

D. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.

E. Vertical Support: Steel riser clamp.

F. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.8 EXPANSION JOINTS AND LOOPS – HOSE AND BRAID

A. Manufacturers:

1. The Metraflex Company; FireLoop.

B. Provide flexible loops with two flexible sections of hose and braid, two 90-degree elbows, and 180-degree return with support bracket and air release or drain plug.

2.9 MECHANICAL COUPLINGS

A. Manufacturers:

1. Anvil International.
2. Shurjoint Piping Products, Inc.
3. Tyco Fire Protection Products.
4. Victaulic Company.

B. Rigid Mechanical Couplings for Grooved Joints:

1. Dimensions and Testing: Comply with AWWA C606.
2. Minimum Working Pressure: 300 psig.
3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
4. Housing Coating: Factory applied orange enamel.
5. Gasket Material: EPDM suitable for operating temperature range from −30°F to 230°F.
6. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.

2.10 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:

1. Activate electric alarm.
2. Test and drain valve.
3. Replaceable internal components without removing valve from installed position.
4. Manufacturers:

a. Victaulic Company; Series 751 with Series 760 motor alarm.

B. Backflow Preventer: Double-check valve assembly backflow preventer with drain and OS & Y gate valve on each end.

1. Manufacturers:

a. Watts, Wilkins, or Zurn.

C. Test Connections:

1. Inspector's Test Connection for Preaction and Dry Pipe Systems:

    a. Provide test connections approximately 6 feet above floor for each or portion of each sprinkler system equipped with an alarm device, located at most remote part of each system.
    b. Route test connection to an open-site drain location, excluding janitor sinks, accepting full flow without negative consequences.
    c. Supply discharge orifice with same size as corresponding sprinkler orifice.
    d. Limit vertical height of exterior wall penetration to 2 feet above finished grade.

2. Combination Inspector's Test Connection and Drain Valve:

    a. Provide test connections approximately 6 feet above floor for each or portion of each sprinkler system equipped with an alarm device, located at most remote part of each system.
    b. Route combination test connection and drain valve to an open-site drain location, excluding janitor sinks, accepting full flow without negative consequences.
    c. Supply discharge orifice with same size as corresponding sprinkler orifice.
    d. Limit vertical height of exterior wall penetration to 2 feet above finished grade.

D. Water Flow Switch: Vane-type switch for mounting horizontally or vertically, with two contacts; rated 10 A at 125 VAC and 2.5 A at 24 VDC.

E. Fire Department Connections:

1. Type: Exposed, projected wall mount made of corrosion-resistant metal complying with UL 405.

    a. Inlets: Two-way, 2½ inch swivel fittings, internal threaded. Thread size and inlets according to NFPA 1963 or authority having jurisdiction. Brass caps with gaskets, chains, and lugs.
    b. Configuration: Horizontal.
    c. Outlet: Back with pipe threads, 4 NPS.

        1) Location: Back.

    d. Rated Working Pressure: 175 psi.
    e. Finish: Chrome.
    f. Sleeve: Brass, 18-inch height.
    g. Signage: Raised or engraved lettering 1 inch, minimum, indicating system type.
    h. Manufacturers:

        1) Elkhart Brass Manufacturing Company, Inc.

F. Supervisory Switches:

1. Manufacturers:

    a. Potter Electric Signal Company, LLC; CoilKeeper Solenoid Supervisory Switch.

2.11 PRESSURE GAUGES

A. Manufacturers:

1. AGF Manufacturing.
2. Dwyer Instruments, Inc.
3. Moeller Instrument Company, Inc.

B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

1. Case: Steel with brass bourdon tube.
2. Diameter: 4½ inches.
3. Midscale Accuracy: 1%.
4. Scale: Display in psi and kPa.

PART 3 - EXECUTION

3.1 COORDINATION

A. Refer to Division 01 Section “Project Management and Coordination”.

B. Coordinate available space for equipment and systems with other trades. Refer to Architectural, Structural and Electrical Drawings for additional building details necessary for coordination.

C. Cutting, patching, wiring, finishing or any other work required for relocation of work installed due to interferences between the work of the various trades will be at no additional cost to the Tenant.

3.2 MANUFACTURER’S INSTRUCTIONS

A. Furnish proper equipment and/or materials required for installation as intended by the manufacturer, for all work described under Division 21. If needed for proper installation or operation, request advice and supervisory assistance from the representative of the specific manufacturer. Manufacturer’s published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufactured materials or equipment, unless otherwise indicated. Promptly notify the Architect in writing of any conflict between the requirements of the Contract Documents and the manufacturer’s directions and obtain the Architect’s instructions before proceeding with the work.

3.3 EXAMINATION OF SITE

A. Visit site of proposed work and become familiar with conditions affecting work. Verify measurements at the building before beginning work.

3.4 EXISTING UTILITIES AND PIPING

A. Locations of existing concealed lines and connection points have been indicated as closely as possible from available information. Assume that such connection points are within a 10-foot (10') radius of indicated locations. Where connection points are not within this radius, contact the Architect for a decision before proceeding.

3.5 LAYING OUT WORK

A. Locations of equipment and devices, as shown on the drawings, are approximate unless dimensioned. Exact locations of such items shall be determined from the Construction Drawings. Verify physical dimensions of each item of mechanical equipment, piping system, to fit available space and promptly notify the Architect prior to roughing-in if conflicts appear. Coordinate equipment to available space and access routes through construction. Offsets or transitions in piping systems required for proper system operation and/or installation, whether indicated on drawings or not, shall be provided at no additional cost to Tenant.

3.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials at the site unless offsite storage is authorized in writing. Protect stored equipment and materials from damage.

C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

3.7 ACCESSIBILITY

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate location of concealed equipment and devices requiring access with location of access panels and doors. Allow ample space for removal of parts that require replacement or servicing.

3.8 CUTTING AND PATCHING

A. Comply with Division 01 Section, "Execution" for general requirements for cutting and patching.

B. Cutting shall be performed with masonry saws, core drills or similar equipment to provide neat and uniform openings.

C. Patching shall match adjacent surfaces in materials and finish. Do not endanger or damage installed work through procedures and processes of cutting and patching.

D. Arrange for repairs required to restore other work, which was damaged because of mechanical installations. Upon receipt of written authorization from Architect, Contractor will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.

E. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.

F. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed work.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements of the Contract Documents.
4. Remove samples of installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Upon written instructions from the Architect, uncover and restore work to provide for observation of concealed work.

G. Cut, remove, and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping, heating units, and other mechanical items made obsolete by new work.

H. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

I. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

3.9 EXCAVATING AND BACKFILLING

A. Provide trench and pit excavation and backfilling required for mechanical work, inside and outside the building, including repairing of finished surfaces, required shoring, bracing, pumping, and protection for safety of persons and property. Remove excess earth resulting from their work from the site. Comply with Local or State safety codes. Check the elevations of the utilities entering and leaving the building. If such elevations require excavations lower than the footing levels, notify the Architect of such conditions before excavations commence. Make the excavations at the minimum required depths to not undercut the footings.

3.10 FILLING, BACKFILLING, AND COMPACTION

A. General: Remove debris and decayable matter from areas to be filled before proceeding. Use only materials approved by the Architect for fills. Obtain Architect’s approval before filling against concrete or masonry walls. Make fills as soon as feasible to insure maximum settlement.

B. Compaction of Fills: Compact by ASTM D1557, Method “A,” 95% density under paved areas and building areas to 10 feet beyond building perimeter, 90% elsewhere. Place fills in lifts which, when compacted, shall not exceed 8-inches in depth and compact with multiple-wheeled pneumatic-tired rollers or other approved methods. Fills made from cuts shall be made and

compacted in one operation so that the material is not left exposed to rain while in an uncompacted state.

C. Fills under Interior Slabs: 4-inches of ¾-inch to 1½ inches washed gravel, evenly graded. Cover with reinforced Kraft paper. Lap joints 4-inches, turn up 4-inches onto vertical surfaces. Repair any punctures in membrane before pouring concrete.

3.11 EXISTING PIPING

A. Contractor is required to test existing fire protection systems with the Reliable Sure-Off Tester or equal.

3.12 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

3.13 INSTALLATION

A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.

B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

C. Install piping to conserve building space, to not interfere with use of space and other work.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Pipe Hangers and Supports:

1. Install hangers to provide minimum ½ inch space between finished covering and adjacent work.
2. Place hangers within 12 inches of each horizontal elbow.
3. Use hangers with 1½ inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
6. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

G. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

H. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.

I. Structural Considerations:

1. Do not penetrate building structural members unless indicated.
2. Locate flexible expansion loops at or near the building seismic joint.

J. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.

1. Aboveground Piping:

a. Pack solid using mineral fiber complying with ASTM C592.
b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.

2. All Rated Openings: Caulk tight with firestopping material complying with ASTM E814 in accordance with Section 078413 to prevent the spread of fire, smoke, and gases.

K. Manufactured Sleeve-Seal Systems:

1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in the center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a watertight seal.
6. Install in accordance with manufacturer’s recommendations.

L. Escutcheons:

1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
3. Use chrome-plated escutcheons in occupied spaces and to conceal openings in construction.

M. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

3.14 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION 210500

SECTION 210505 – PROJECT CLOSEOUT FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this section.

1.2 SCOPE OF WORK – GENERAL

A. This section specifies procedural requirements for Fire Suppression installations project closeout, including but not limited to:

1. Project Record Document submittal.
2. Operation and Maintenance Manual submittal.
3. Operation and Maintenance Instruction and Training.
4. Fire Suppression Equipment and Systems Startup.
5. Final Cleaning.
6. Tenant Training Session Agenda.

1.3 Related Sections include the following:

A. Division 01 Section, “Submittal Procedures”.

B. Division 01 Section “Closeout Procedures”.

1.4 PROJECT RECORD DOCUMENTS

A. Record differences between Fire Suppression work as installed and as shown in Contract Drawings on a set of prints of Fire Suppression drawings furnished by Architect. Return these prints to the Architect at completion of project. Notations made on drawings shall be neat and legible. Comply with Division 01 Section requirements.

B. Mark drawings to indicate revisions to Fire Suppression piping, size and location both exterior and interior; including locations of coils, dampers, and other control devices, filters, motors, and similar items requiring periodic maintenance; actual equipment locations; concealed equipment and control devices; mains and branches of piping systems, with valves and control devices located and numbered.

C. Revise equipment and fixture schedules on the Drawings to indicate actual installed manufacturer and model numbers.

D. Mark specifications to indicate change orders; actual equipment and materials used.

1.5 OPERATION AND MAINTENANCE MANUALS

A. Prepare and submit Operation and Maintenance (O&M) Manuals for Fire Suppression systems provided. Comply with Division 01 requirements.

B. Provide a primary index at beginning of Manual showing sections and items included.

C. Cover section: List name, address, and phone number of Project Architect, General Contractor, Fire Suppression Contractor, and all Fire Suppression Subcontractors. Provide a list of equipment suppliers with address and phone number.

D. Include descriptive literature (manufacturer's catalog data) of each manufactured item. Literature shall show capacities and size of equipment used and be marked indicating each specific item with applicable data underlined. Data sheets shall be originals or clean copies of originals.

E. One draft copy of the manual shall be submitted for review, comment, and approval, as applicable, at least fifteen (15) days prior to substantial completion or training, whichever is first. After approval, submit three (3) copies of the manual to Architect for approval unless otherwise directed by Division 01 Section requirements. Information to be included in manual:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
2. Manufacturer's printed operating procedures to include startup, break-in, routine, and normal operating instructions; regulation, control, stopping shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
5. Valve schedule indicating the valve symbol (tag number), valve location by room number and description, valve purpose and system served, and valve size. Provide one (1) corresponding set of full-size Fire Suppression prints showing these valve locations for cross-reference. A second, complete set of valve schedules (8½ inches x 11 inches) encased in transparent plastic laminate and fitted in an aluminum holding frame shall be furnished to the Tenant.
6. Test records and certifications.
7. Equipment startup reports.
8. Warranty information and letters of guarantee.
9. Instruction period checklist for each equipment item.

F. Complete O&M Manual shall be available for use by Tenant's representatives during instruction and training sessions.

1.6 OPERATION AND MAINTENANCE INSTRUCTION AND TRAINING

A. Instruct Tenant's Representative(s) in the Operation and Maintenance procedures described in Operation and Maintenance Manual. Comply with Division 01 Section requirements.

B. Enlist the services of qualified personnel, including each subcontracted trade and factory trained specialists for each major piece of equipment, to attend training sessions and provide operation and maintenance instructions.

C. Submit training agenda, schedule, and list of representatives for review thirty (30) days prior to training sessions. Confirm attendance by written notification to all participants.

D. Prepare a checklist of all equipment and systems requiring instruction and maintenance for verification and agreement by the Tenant's Representative of satisfactory startup and instruction. Checklist shall include a statement of completion by the Contractor, date and topic(s) covered in each training session, and an attendance list of all participants at each training session. Submit a copy of checklist for review thirty (30) days prior to training sessions. Include copy of the completed checklist in Operation and Maintenance Manual.

E. Refer to individual Division 21 Sections for additional instruction/training requirements.

F. All Fire Suppression systems shall be properly functioning prior to instruction period.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 FIRE SUPPRESSION EQUIPMENT AND SYSTEMS STARTUP

A. Provide the services of a factory-authorized service representative to test and inspect unit installation, provide startup service, and demonstrate and train Tenant's maintenance personnel.

B. Include certification of factory-authorized representative status as part of equipment submittal from manufacturer. Include copies of any installation and startup instructions, manufacturer's checklists, and other forms used in startup as part of the equipment submittal.

C. Include written startup reports with test data for equipment in Operation and Maintenance Manual.

D. All construction debris, including electrical wiring debris, shall be removed from units prior to equipment startup. Areas surrounding and served by equipment being started must be free of construction debris, sheetrock dust, and any materials that may adversely affect the equipment.

3.2 FINAL CLEANING

A. Refer to Division 01 for final cleaning.

B. At time of final cleanup, clean all fixtures and equipment, and leave in condition for use intended. Vacuum cabinet interiors of control panels, air handling units, etc. to remove all construction debris including electrical wiring debris.

END OF SECTION 210505

SECTION 211300 – FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wet-pipe sprinkler system.

B. System design, installation, and certification.

1.2 REFERENCE STANDARDS

A. The publications listed below form a part of this Specification to the extent referenced. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1. ASME B16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.4 – Gray Iron Threaded Fittings: Classes 125 and 250.
3. ASME B16.5 – Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.
4. ASME B16.9 – Factory-Made Wrought Buttwelding Fittings.
5. ASME B16.21 – Nonmetallic Flat Gaskets for Pipe Flanges.
6. ASTM A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
7. ASTM A234/A234M – Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
8. ASTM A733 – Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples.
9. ASTM A865/A865M – Standard Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints.
10. AWS D10.12M/D10.12 – Guide for Welding Mild Steel Pipe.
11. NFPA 13 – Standard for the Installation of Sprinkler Systems.
12. UL 860 – Standard for Pipe Unions for Flammable and Combustible Fluids and Fire Protection Service.
13. UL 1474 – Standard for Adjustable Drop Nipples for Sprinkler Systems.

1.3 SUBMITTALS

A. See Section 210500 – Common Work Results for Fire Suppression for submittal procedures.

B. Shop Drawings:

1. Sprinkler design changes shall be signed by a NICET level III or higher professional. Include sprinkler design professional’s Registration of Certification.

2. Indicate hydraulic calculations for any design changes, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
3. Submit shop drawings to Authorities Having Jurisdiction for approval. Submit proof of approval to Architect.
4. Submit hydraulic calculations for design changes for each sprinkler system in accordance with NFPA 13. Provide a 10-psi safety factor between the water supply and the calculated demand requirement.

C. Maintenance Materials: Furnish the following for Tenant's use in maintenance of project.

1. Extra Sprinklers: Type and size matching those installed in quantity required by referenced NFPA design and installation standard.
2. Sprinkler Wrenches: For each sprinkler type.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Standard-Weight, Black Steel Pipe: ASTM A53/A53M, Grade B, Seamless. Pipe ends may be factory or field formed to match joining method.

1. Required for welded fittings, cut groove fittings of all sizes, and threaded fittings 2 inches and smaller.

B. Black Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.

C. Uncoated Steel Couplings: ASTM A865/A865M, threaded.

D. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

E. Malleable- or Ductile-Iron Unions: UL 860.

F. Cast-Iron Flanges: ASME B16.1, Class 125.

G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic and asbestos free.

a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

H. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.2 SPRINKLER SYSTEM

A. Sprinkler System: Provide coverage for the entire building.

B. Occupancy: Light hazard; comply with NFPA 13.

C. Water Supply: Determine volume and pressure from water flow test data.

D. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.3 SPRINKLERS

A. Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.

1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Chrome-plated.
4. Cover Plate Finish: Color to match ceiling.
5. Fusible Link: Glass bulb type temperature rated for specific area hazard.

B. Exposed Area Type: Pendant type.

1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Brass.
4. Fusible Link: Glass bulb type temperature rated for specific area hazard.

C. Sidewall Type: Semi-recessed horizontal sidewall type with matching push-on escutcheon plate.

1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Chrome-plated.
4. Escutcheon Plate Finish: Chrome-plated.
5. Fusible Link: Glass bulb type temperature rated for specific area hazard.

D. Dry Sidewall Type: Semi-recessed horizontal dry sidewall type with matching push on escutcheon plate.

1. Response Type: Quick.
2. Coverage Type: Standard.
3. Fusible Link: Glass bulb type temperature rated for specific area hazard.

E. Flexible Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Pressure Rating: 175-psig minimum.
4. Size: Same as connected piping, for sprinkler.

2.4 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:

1. Activate electric alarm.
2. Test and drain valve.
3. Replaceable internal components without removing valve from installed position.
4. Manufacturers:

a. Victaulic Company; Series 751 with Series 760 motor alarm.

B. Electric Alarm: Electrically operated chrome-plated gong with pressure alarm switch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with referenced NFPA design and installation standards.

B. Install equipment in accordance with manufacturer’s instructions.

C. Locate the outside alarm gong on the building wall as indicated.

D. Place pipe runs to minimize obstruction to other work.

E. Place piping in concealed spaces above finished ceilings.

F. Center sprinklers in two directions in ceiling tile and provide piping offsets as required.

G. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.

H. Flush entire piping system of foreign matter.

I. Hydrostatically test the entire system.

J. Require test be witnessed by Fire Marshal.

END OF SECTION 211300

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feetabove sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 220513

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Silicone sealants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot dip galvanized, with plain ends and integral welded waterstop collar.

C. Galvanized-Steel Sheet Sleeves: ASTM A653/A653M, 0.0239-inchminimum thickness; round tube closed with welded longitudinal joint.

D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Designed to form a hydrostatic seal of 20 psigminimum.
2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 coating of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000 psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inchannular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inchesabove finished floor level.

2. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inchannular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout or silicone sealant, seal the space around outside of sleeves.

3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
2. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

3.5 SLEEVE SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inchannular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. Sleeves with waterstops.

4. Interior Partitions:

a. Sleeves without waterstops.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. BrassCraft Manufacturing.
2. Dearborn Brass.
3. ProFlo; a Ferguson Enterprises, Inc.

2.2 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.

E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed and exposed-rivet hinge; and spring-clip fasteners.

2.3 FLOOR PLATES

A. Split Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
b. Chrome-Plated Piping: One-piece steel with polished, chrome-plated finish.
c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor plate.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 220518

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Light-activated thermometers.
3. Thermowells.
4. Pressure gages.
5. Test plugs.
6. Test-plug kits.
7. Sight flow indicators.

B. Related Requirements:

1. Section 221119 "Domestic Water Piping Specialties" for water meters.
2. Division 33 for domestic water meters and combined domestic and fire-protection water-service meters outside the building.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Trerice.
    b. Weiss Instruments
    c. Winters Instruments.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 6-inchnominal size.
4. Case Form: Back angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass or plastic.
8. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

9. Connector: 3/4 inch, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Trerice.
    b. Weiss Instruments
    c. Winters Instruments.

2. Standard: ASME B40.200.
3. Case: Plastic; 6-inchnominal size.
4. Case Form: Back angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F.
7. Window: Glass or plastic.
8. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

9. Connector: 3/4 inch, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 LIGHT-ACTIVATED THERMOMETERS

A. Direct-Mounted, Light-Activated Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Trerice.
    b. Weiss Instruments
    c. Winters Instruments.

2. Case: Plastic; 9-inch nominal size unless otherwise indicated.
3. Scale(s): Deg F.
4. Case Form: Adjustable angle.
5. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
6. Stem: Aluminum and length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

7. Display: Digital.
8. Accuracy: Plus or minus 2 deg F.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Trerice.
    b. Ashcroft.
    c. Marsh.

2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inchnominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4, ASME B1.20.1 pipe threads.

2.6 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Trerice
2. Weiss Instruments
3. Peterson Equipment Co.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.

J. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be the following:

1. Metal case, compact-style, liquid-in-glass type.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping:

1. 0 to 100 deg F.

B. Scale Range for Domestic Hot-Water Piping:

1. 0 to 250 deg F.

3.6 PRESSURE-GAGE SCHEDULE

1. Liquid-filled, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be the following:

1. Liquid-filled, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping:

1. 0 to 100 psi

B. Scale Range for Domestic Water Piping:

1. 0 to 100 psi.

END OF SECTION 220519

SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. RPTFE: Reinforced polytetrafluoroethylene.

C. WOG: Water, oil, gas.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and soldered ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic water valves intended to convey or dispense water for human consumption must comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or must be certified to be in compliance with NSF 61 and NSF 372 (by an ANSI-accredited third-party certification body) that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for cast copper solder-joint connections.
5. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
6. ASME B16.34 for flanged and threaded end connections
7. ASME B31.9 for building services piping valves.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Type:

1. Gear Actuator: For quarter-turn valves NPS 4and larger.
2. Hand Lever: For quarter-turn valves smaller than NPS 4.

G. Valves in Insulated Piping:

1. Provide 2-inchextended neck stems.
2. Extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.3 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Apollo.
2. Milwaukee.
3. Nibco.

2.4 BRASS BALL VALVES

A. Brass Ball Valves, Two Piece with Full Port and Brass Trim, Threaded or Soldered Ends:

1. Standard: MSS SP-110; MSS SP-145.
2. CWP Rating: 600 psig
3. Body Design: Two piece.
4. Body Material: Forged brass.
5. Ends: Threaded or soldered.
6. Seats: PTFE.
7. Stem: Brass or stainless steel.
8. Ball: Chrome-plated brass or stainless steel.
9. Port: Full.

B. Brass Ball Valves, Two Piece with Full Port and Brass Trim, Press Ends:

1. Standard: MSS SP-110; MSS SP-145; IAPMO/ANSI Z1157.
2. CWP Rating: Minimum 200 psig.
3. Body Design: Two piece.
4. Body Material: Forged brass.
5. Ends: Press.
6. Press-End Connections Rating: Minimum 200 psig.
7. Seats: PTFE or RPTFE.
8. Stem: Brass or stainless steel.
9. Ball: Chrome-plated brass or stainless steel.
10. Port: Full.
11. O-Ring Seal: Buna-N or EPDM.

2.5 BRONZE BALL VALVES

A. Bronze Ball Valves, Two Piece with Full Port, and Bronze or Brass Trim, Threaded or Soldered Ends:

1. Standard: MSS SP-110; MSS SP-145.
2. CWP Rating: 600 psig.
3. Body Design: Two piece.
4. Body Material: Bronze.
5. Ends: Threaded or soldered.
6. Seats: PTFE.

7. Stem: Bronze or brass or stainless steel.
8. Ball: Chrome-plated brass or stainless steel.
9. Port: Full.

B. Bronze Ball Valves, Two Piece with Full Port, and Bronze or Brass Trim, Press Ends:

1. Standard: MSS SP-110; MSS SP-145; IAPMO/ANSI Z1157.
2. CWP Rating: Minimum 200 psig.
3. Body Design: Two piece.
4. Body Material: Bronze.
5. Ends: Press.
6. Press-End Connections Rating: Minimum 200 psig
7. Seats: PTFE or RTPFE.
8. Stem: Bronze or brass or stainless steel.
9. Ball: Chrome-plated brass or stainless steel.
10. Port: Full.
11. O-Ring Seal: EPDM or Buna-N.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.

B. Provide support to piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position to allow full valve actuation movement.

F. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, provide the same types of valves with higher CWP ratings.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4:Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2and Smaller:

1. Brass or bronze ball valves, two piece with full port, and brass or bronze or stainless steel trim. Provide with threaded, soldered or pressure-sealed connection joint ends.

B. Pipe NPS 2-1/2and Larger:

1. Brass or bronze ball valves, two piece with full port, and brass or bronze or stainless steel trim. Provide with threaded, soldered, flanged, or pressure-sealed connection joint ends.

END OF SECTION 220523.12

SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze, swing check valves.
2. Bronze, swing check valves, press ends.
3. Iron, swing check valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer.

C. NBR: Nitrile butadiene rubber (also known as Buna-N).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, press connections, and weld ends.
3. Set check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic water piping check valves intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372, or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges for metric standard piping.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast-copper solder joint.
6. ASME B16.22 for wrought copper solder joint.
7. ASME B16.51 for press joint.
8. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for groove-end connections.

D. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE SWING CHECK VALVES

A. Bronze, Swing Check Valves with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Hammond.
b. Milwaukee.
c. Nibco

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: PTFE.

B. Bronze, Swing Check Valves, Press Ends:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Hammond.
b. Milwaukee.
c. Nibco.

2. Description:

a. Standard: MSS SP-80 and MSS SP-139.
b. CWP Rating: Minimum 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B584, bronze.
e. Ends: Press.
f. Press Ends Connection Rating: Minimum 200 psig
g. Disc: Brass or bronze.

2.4 IRON, SWING CHECK VALVES

A. Iron, Swing Check Valves with Metal Seats, Class 250:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Hammond.
b. Milwaukee.
c. Nibco.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 500 psig.

c. Body Design: Clear or full waterway.
d. Body Material: ASTM A126, gray iron with bolted bonnet.
e. Ends: Flange or threaded. See valve schedule articles.
f. Trim: Bronze.
g. Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Examine press fittings to verify they have been properly press.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. Install valves so that stems are horizontal or slope upward from centerline of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.

H. Check Valves: Install check valves for proper direction of flow.

1. Swing Check Valves: In horizontal position with hinge pin level.

I. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

J. Adhere to manufacturer's installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:

1. For Copper Tubing, NPS 2and Smaller: Threaded, soldered, or press-end connections.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flange or threaded.
3. For Steel Piping, NPS 2 and Smaller: Threaded.
4. For Steel Piping, NPS 2-1/2 to NPS 4: Flange or threaded.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze, swing check valves with nonmetallic disc, Class 150, with soldered end connections.
2. Bronze, swing check valves with press-end connections.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, swing check valves with metal seats, Class 250, with threaded or flange end connections.

END OF SECTION 220523.14

SECTION 220523.15 - GATE VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Iron gate valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer.

C. NRS: Nonrising stem.

D. OS&Y: Outside screw and yoke.

E. RS: Rising stem.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, press connections, and weld ends.
3. Set gate valves closed to prevent rattling.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels, stems, or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic water piping check valves intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372, or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on metric standard piping.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: AWWA C606 for groove-end connections.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valves in Insulated Piping: With 2-inchstem extensions.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.3 IRON GATE VALVES

A. Iron Gate Valves, OS&Y, Class 250:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Hammond.
b. Milwaukee.
c. Nibco.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 500 psig.
c. Body Material: Gray iron with bolted bonnet.
d. Ends: Flange.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. Install valves so that stems are horizontal or slope upward from centerline of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.

H. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

I. Adhere to manufacturer's installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Use gate valves for shutoff service only.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:

1. For Piping, NPS 2-1/2 to NPS 4Flange.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2and Smaller:

B. Pipe NPS 2-1/2and Larger: Iron gate valves, OS&Y, Class 250 with flange ends.

END OF SECTION 220523.15

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal hanger-shield inserts.
5. Fastener systems.
6. Pipe Positioning Systems.
7. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Eaton Corporation, B-line struts.
   b. Thomas & Betts
   c. Unistrut

2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with inturned lips.
5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Metallic Coating: Plain.
9. Paint Coating: Green epoxy, acrylic, or urethane.

2.5 THERMAL HANGER-SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psigor ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psigor ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Zinc-coated steel.
2. Outdoor Applications: Stainless steel.

2.7 PIPE-POSITIONING SYSTEMS

A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.9 MATERIALS

A. Aluminum: ASTM B221

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

M. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

O. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 incheslong and 0.048 inch thick.
b. NPS 4: 12 incheslong and 0.06 inchthick.

5. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal hanger-shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inchesof insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
15. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
16. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
17. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
18. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg Fpiping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg Fpiping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. C-Clamps (MSS Type 23): For structural shapes.
6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
11. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220548.13 - VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe-Riser Resilient Support
2. Vibration Isolators.
3. Restraints – Rigid Type.
4. Restraints – Cable Type.
5. Isolator Accessories
6. Restraint Accessories.
7. Mechanical Anchor Bolts

B. Related Requirements:

1. Section 230548.13 "Vibration Controls for HVAC" for devices for HVAC equipment and systems.

1.3 DEFINITIONS

A. IBC: International Building Code.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device component.
3. Annotate to indicate application of each product submitted and compliance with requirements.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration device installation for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design system.

2.2 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch-Thick Neoprene:

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psi on isolation material providing equal isolation in all directions.
3. Minimum deflection as indicated on Drawings.

2.3 VIBRATION ISOLATORS

A. Neoprene or Fiberglass Hangers, Type SH-3: Cone-shaped elastomeric mounting made from neoprene with a steel box frame, open on two sides, containing a double deflection neoprene element with a projecting bushing to prevent steel to steel contact. Hanger rod shall penetrate neoprene element and steel frame with sufficient clearance to allow it to swing through a 30-degree arc before contacting neoprene bushing at the perimeter of the lower hole in the frame. Hole in top of box frame for bolting to structure.

1. Mason Industries type HD
2. Or approved equivalent.

2.4

2.5 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. California Dynamics.
2. Mason Industries.
3. Vibration Elimination Co.

B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.6 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. nVent.
2. Vibration Mountings and Controls, Inc.

B. Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19-10**.** All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.7 ISOLATOR ACCESSORIES

A. Cushion Sleeve: Neoprene pad 1/4-inch minimum thickness for use as a noise and vibration isolator between piping and its supporting or suspension system. Sleeve shall be split or hinged and shall have an exterior metal shell to prevent crushing during installation.

1. Mason Industries Type SWS.
2. Or approved equivalent.

B. Acoustical Insulation: 1/2- to 6-inch-thick low density unfaced fiberglass batts.

1. Owens Corning Standard.
2. Or approved equivalent.

C. Mineral Fiber Insulation: 2- to 3-inch-thick fire-rated mineral fiber insulation batts.

1. USG Thermafiber.
2. Or approved equivalent.

D. Resilient Caulk: Paintable and non-hardening.

1. USG Acoustical Sealant.
2. Pecora Corporation Acoustical Sealant BA098.
3. 3M Vibration Control Systems Fire Stop 2000.

E. Clay Packing: Moldable, non-curing, one component fire-rated putty pads for protection of electrical outlet boxes and reduction of sound transmission.

1. Johns Manville Firetemp Intumescent Putty Pads

F. Resilient Isolation Washer Bushings: To be used such that direct contact between bolt and equipment is eliminated. One-piece, molded, oil- and water-resistant neoprene, with a flat washer face. Manufactured of bridge-bearing neoprene. Maximum loading not to exceed 1000 psi.

2.8 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. California Dynamics.
2. Mason Industries.
3. Vibration Elimination Co.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

D. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.9 MECHANICAL ANCHOR BOLTS

A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static forces within specified loading limits.

3.3 INSTALLATION OF VIBRATION-CONTROL DEVICES

A. Provide vibration-control devices for systems and equipment where the Specifications indicate they are to be installed on specific equipment and systems.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Equipment Restraints:

1. Install snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

D. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

E. Install cables so they do not bend across edges of adjacent equipment or building structure.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL MOTION

A. Provide flexible connections in piping systems where they cross structural joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 221116 "Domestic Water Piping" and Section 221119 "Domestic Water Piping Specialties" for piping flexible connections.

3.5 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

C. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.

D. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

E. Test no fewer than **four** of each type and size of installed anchors and fasteners selected by Architect.

F. Test to 90 percent of rated proof load of device.

G. Remove and replace malfunctioning units and retest as specified above.

H. Units will be considered defective if they do not pass tests and inspections.

I. Prepare test and inspection reports.

3.7 VIBRATION ISOLATION SCHEDULES

A. Schedule.

3.8

Equipment	Isolator	Deflection in Inches	Base	Flexible Connector	Notes
Pumps	SH-3	0.2	--	--	1,2,3

A. Notes:

1. See section, Seismic anchorage and restraints
2. See Mechanical and Structural Drawings

3. Install flexible piping connectors between piping and equipment supported by vibration isolators to limit vibration transfer.

END OF SECTION 220548.13

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Warning tape.
4. Pipe labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve-numbering scheme.

D. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Brady.
2. Craftmark.
3. Seton.

C. Material and Thickness: Multilayer, multicolor, plastic or aluminum labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

D. Letter and Background Color: As indicated for specific application under Part 3.

E. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

H. Fasteners: Stainless steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

K. Label Content: Include equipment's drawing designation and unique equipment number. Include caution and warning information plus emergency notification instructions.

2.2 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Brady.
2. Craftmark.
3. Seton.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations (full system name) as used on Drawings. Also include:

1. System name.
2. Pipe size.
3. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
4. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.3 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Brady.
2. Craftmark.
3. Seton.

B. Description: Stamped or engraved with 1/2-inchletters and numbers.

1. Tag Material: Brass or aluminum, no. 14 gage thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire, link chain or beaded chain or S-hook.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inchbond paper.

1. Mark valves for emergency shutoff and similar special uses.
2. Include valve-tag schedule in operation and maintenance data.
3. Tabulate all of the following, and include on valve tag, the information indicated below:

a. Building
b. Area/room
c. System abbreviation (include on tag)
d. Valve size
e. Supply or Return or omit if not applicable
f. Normal operating position, open or closed or modulating
g. Valve number (include on tag)
h. Valve type, control, balancing, shut-off, etc.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of plumbing equipment. Equipment labels shall include all scheduled equipment per drawings except plumbing fixtures but including trap primers.

B. Sign and Label Colors.

1. White letters on an black background.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where are-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E**,** and other applicable codes and standards.

3.4 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft.of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

C. Piping less than or equal to 1-1/2 inches in diameter may use 4” x 2” brass identification tag stamped with ½ text.

D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

E. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

F. Pipe-Label Color Schedule:

1. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
2. Domestic Hot-Water Supply Piping: White letters on an yellow background.
3. Domestic Hot-Water Return Piping: White letters on an yellow background.
4. Sanitary Waste and Storm Drainage Piping: White letters on a green background.

3.5 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except valves within factory-fabricated equipment units, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape:

    a. Domestic Cold Water: 4 by 2 inches.
    b. Domestic Hot Water: 4 by 2 inches.
    c. Domestic Hot-Water Return: 4 by 2 inches.

2. Valve-Tag Colors:

    a. No color

END OF SECTION 220553

SECTION 220593 - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. TAB of domestic water system.
2. TAB of plumbing equipment:

    a. Domestic hot-water in-line circulation pumps.

3. Pipe-leakage test verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

C. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

D. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

E. Certified TAB reports.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by NEBB or TABB:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine approved submittals for plumbing systems and equipment.

D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.

E. Examine equipment performance data, including pump curves.

1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.

F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

I. Examine operating safety interlocks and controls on plumbing equipment.

J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Domestic Water System:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
b. Water heaters are installed and functioning.
c. Piping is complete and all points of outlet are installed.
d. Water treatment is complete.
e. Systems are flushed, filled, and air purged.
f. Shutoff and balance valves are 100 percent open.

g. Hot water circulating pumps are operational and proper rotation is verified.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220719 "Plumbing Piping Insulation."

C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:

1. Domestic water in-line pumps.
2. Domestic water heaters.

3.5 PROCEDURES FOR DOMESTIC WATER SYSTEMS

A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check water heater for proper discharge temperature setting.
3. Check remotest point of outlet for adequate pressure.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.

5. Verify that motor controllers are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

G. Check settings and operation of each safety valve. Record settings.

3.6 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

A. Balance system with manual or automatic balancing valves by setting at design flow.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

B. Adjust pump to deliver total design flow.

1. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
3. Mark final settings and verify that all memory stops have been set.
4. Verify final system conditions as follows:

a. Re-measure and confirm that total flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
c. Mark final settings.

3.7 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.

2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.8 PROCEDURES FOR WATER HEATERS

A. Electric Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. Record relief valve(s) pressure setting.
5. Capacity: Calculate in Btu/hof heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

3.9 TOLERANCES

A. Set plumbing system's flow rates within the following tolerances:

1. Domestic Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm within 10 percent.

3.10 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for pump performance forms, including the following:

    a. Settings for pressure controller(s).
    b. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:

1. Flow rates.
2. Pipe and valve sizes and locations.
3. Balancing stations.
4. Position of balancing devices.

E. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Model number and unit size.
    d. Manufacturer's serial number.
    e. Output capacity in Btu/h.
    f. Number of stages.
    g. Connected volts, phase, and hertz.
    h. Rated amperage.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. High-temperature-limit setting in deg F.
e. Operating set point in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water-pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump speed.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

G. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.

c. Application.
d. Dates of use.
e. Dates of calibration.

3.11 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.

B. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.

F. Prepare test and inspection reports.

END OF SECTION 220593

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Supplies and drains for handicap-accessible lavatories and sinks.
5. Roof drains and rainwater leaders.

B. Related Sections:

1. Section 230719 “HVAC Piping Insulation” for other piping insulation
2. Section 238129 "Variable Refrigerant Flow HVAC Systems" for system piping insulation requirements for refrigerant and condensate piping

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at pipe expansion joints for each type of insulation.
3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4. Detail removable insulation at piping specialties, equipment connections, and access panels.
5. Detail application of field-applied jackets.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size.

B. Materials on site shall be stored inside, protected from weather conditions, and shall not be subjected to direct, or indirect, moisture. Any insulation which has been subjected to moisture should be removed from the site and shall not be used or installed.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation of testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities

having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg Fand 220 deg F. Comply with ASTM C534/C534M, Type I for tubular materials.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Aeroflex.
b. Armacell.
c. K-Flex.

G. **Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.**

1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:**

a. **Johns Manville; a Berkshire Hathaway company.**
b. **Owens Corning**.
c. **ROCKWOOL**.

2. **Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.**
3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.

4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Mineral Wool, Preformed Pipe: Mandrel-wound mineral wool fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg F in accordance with ASTM C447. Comply with ASTM C547.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Johns Manville; a Berkshire Hathaway company.
b. Owens Corning.
c. ROCKWOOL.

2. Preformed Pipe Insulation: Type II, Grade A with factory applied ASJ.
3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.

I. Mineral Wool, Pipe and Tank: Mineral wool fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1000 deg F, in accordance with ASTM C411. Comply with ASTM C1393.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Johns Manville; a Berkshire Hathaway company.
b. Owens Corning.
c. ROCKWOOL.

2. Semirigid board material with factory applied ASJ or ASJ+ jacket.
3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Wet Flash Point: Below 0 deg F.
4. Service Temperature Range: 40 to 200 deg F.

C. Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.

2. For indoor application, use adhesive that has a VOC content of 80g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. ASJ Flashing Sealants and PVDC and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F
4. For indoor application, use adhesive that has a VOC content of 420g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall be ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; comply with ASTM C1136, Type I, unless otherwise indicated.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. 3M Industrial Adhesives and Tapes Division.
   b. Avery Dennison Corporation, Specialty Tapes Division.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.8 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.

2.9 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Engineered Brass Company.
   b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
   c. McGuire Manufacturing.
   d. Plumberex.
   e. Truebro; a brand of IPS Corporation.
   f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 milsthick and an epoxy finish 5 milsthick if operating in a temperature range of between 140 and 300 deg FConsult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg Fwith an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Cut insulation in a manner to avoid compressing insulation.

L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inchesbeyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

N. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered or routed fittings made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
7. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation conforms to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inchesover adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

    a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Comply with requirements in Section 238129 "Variable Refrigerant Flow HVAC Systems" for system piping insulation requirements for refrigerant and condensate piping.

B. Comply with minimum requirements of ASHRAE 90.1 – 2019 per table below:

Fluid Operating Temperature Range (°F)	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity (Btu*in/h*ft^2*°F)	Mean Rating Temperature (°F)	< 1	1 to < 1-1/2	1-1/2 to < 4	4 to < 8	≥ 8

			Insulation Thickness (in.)				
> 350	0.32 to 0.34	250	4.5	5.0	5.0	5.0	5.0
251 to 350	0.29 to 0.32	200	3.0	4.0	4.5	4.5	4.5
201 to 250	0.27 to 0.30	150	2.5	2.5	2.5	3.0	3.0
141 to 200	0.25 to 0.29	125	1.5	1.5	2.0	2.0	2.0
105 to 140	0.22 to 0.28	100	1.0	1.0	1.5	1.5	1.5
40 to 105	0.21 to 0.27	75	0.5	0.5	1.0	1.0	1.0
< 40	0.20 to 0.26	50	0.5	1.0	1.0	1.0	1.5

Note: Table above is per ASHRAE 90.1-2019 and is applicable to hot water heating, chilled water, domestic hot and cold water.

C. Domestic Cold, Hot and Recirculated Hot Water:

1. Insulation is the following: Flexible Elastomeric or Mineral Wool.

D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation is the following: Protective Shielding Pipe Covers

E. Roof Drain and Overflow Drain Bodies, Leaders, Piping:

1. Mineral-Fiber, Preformed Pipe Insulation, Type I, 1-inch thick.
2. Flexible Elastomeric or Mineral Wool: 1 inchthick.

F. Floor Drains, Traps, Condensate Drain and Sanitary Drain Piping within 10 Feetof Drain Receiving Condensate and Equipment Drain Water below 60 Deg F where located above ground.

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric or Mineral Wool: 1 inchthick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Indoor - exposed

1. Where ASJ is not factory applied to insulation, provide field applied ASJ.

D. Indoor – concealed

1. None.

END OF SECTION 220719

SECTION 220800 - COMMISSIONING FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Owner's Project Requirements and Basis-of-Design Document are included by reference for information only.

C. ASHRAE Guideline 0 and 1.

D. Project’s Commissioning Plan: The commissioning plan is prepared by CxA and expands and makes more specific the information contained here.

1.2 SUMMARY

A. Section includes commissioning process requirements for plumbing systems, assemblies, and equipment.

B. The Commissioning (Cx) process requires the active involvement of the responsible builder (General Contractor or Construction Manager) and the affected Division contractors (Subs) and assigns work and responsibilities that are specified here. (For this specification "Construction Manager" or "CM" will be used to refer to the responsible builder.)

1.3 COMMISSIONING

A. Section includes Cx process requirements for the following plumbing systems, assemblies, and equipment:

1. Domestic hot- and cold-water piping.
2. Booster Pumps.
3. Ejector Pumps.
4. Elevator Pit Pumps.
5. Sump Pumps.
6. Storm drainage piping.
7. Plumbing pumps.
8. Dishwashers.
9. Dishwasher connections.
10. Plumbing equipment.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.

2. For construction checklists, comply with requirements in various Division 22 Sections specifying plumbing systems, system components, equipment, and products.

1.4 DEFINITIONS

A. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

B. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

C. IAPMO: International Association of Plumbing and Mechanical Officials.

D. IgCC: International Green Construction Code.

E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.5 QUALITY ASSURANCE

A. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 220800

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. PEX tube and fittings.
3. Piping joining materials.
4. Transition fittings.
5. Dielectric fittings.

B. Related Requirements:

1. Div. 33 specifications for water-service piping outside the building from source to the point where water-service piping enters the building.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. System purging and disinfecting activities report.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88, Type K, Type L.

B. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

D. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

E. Wrought Copper Unions: ASME B16.22.

F. Copper Tube, Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, manufacturer shall be the following.

a. a. Viega LLC, ProPress

2. Source Limitations: Obtain pressure-seal-joint fittings, copper or bronze, from single manufacturer.
3. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
4. Tools: Manufacturer’s specific tools intended for the application of pressure seal fittings of the correct size.
5. Minimum 200-psigworking-pressure rating at 250 deg F.

2.3 CPVC PIPING

A. Source Limitations: Obtain CPVC piping from single manufacturer.

B. CPVC Pipe: ASTM F441/F441M, with wall thickness as indicated in "Piping Applications" Article.

C. CPVC Socket Fittings: ASTM F438 for Schedule 40 and ASTM F439 for Schedule 80.

D. CPVC Threaded Fittings: ASTM F437, Schedule 80.

E. CPVC Piping System: ASTM D2846/D2846M, SDR 11, pipe and socket fittings.

2.4 PEX TUBE AND FITTINGS

A. PEX Tube and Fittings for Domestic Water

1. Source Limitations: Obtain PEX tube and fittings from single manufacturer.

B. Tube Material: PEX plastic in accordance with ASTM F876/F877

C. Fittings: elbows, adapters, couplings, plugs, tees, and multi-port tees, etc.: ASTM F1807, metal insert and copper crimp rings. ASTM F1960 cold-expansion fitting and reinforcing rings.

D. Push-Fit Fittings: ASSE 1061, push-fit fittings.

E. Multi-Port Tees: Multiple outlet fitting complying with ASTM F877; with ASTM F 1960 inlets and outlets.

F. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F876; with plastic or corrosion-resistant-metal valve for each outlet.

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inchthick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.

2.6 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. PEX-to-Metal Transition Fittings:

1. Provide fittings from the same manufacturer of the piping.
2. Threaded Brass to PEX-a Transition: one-piece brass fitting with male or female threaded adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
3. Brass Sweat to PEX-a Transition: one-piece brass fitting with sweat adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.

D. Plastic-to-Metal Transition Fittings - Domestic Water:

1. Source Limitations: Obtain plastic-to-metal transition fittings from single source.
2. Description:

a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions - Domestic Water:

1. Source Limitations: Obtain plastic-to-metal transition unions from single manufacturer.
2. Description:

a. CPVC four-part union.
b. Brass or stainless steel threaded end.
c. Solvent-cement-joint or threaded plastic end.
d. Rubber O-ring.
e. Union nut.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Hart Industries International, Inc.
d. Jomar International Ltd.
e. Matco-Norca, Inc.
f. McDonald, A. Y. Mfg. Co.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
h. Wilkins; a Zurn company.

2. Standard: ASSE 1079.
3. Pressure Rating: 150 psig

4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Hart Industries International, Inc.
d. Jomar International Ltd.
e. Matco-Norca, Inc.
f. McDonald, A. Y. Mfg. Co.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
h. Wilkins; a Zurn company.

2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 150 psig.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, and non-potable water, building service piping, all sizes, available materials for use shall be the following:

1. Copper tube, ASTM B88, Type K; wrought-copper fitting, solder-joint fittings; and brazed or soldered joints, or copper pressure-seal fittings and pressure-sealed joints.
2. PEX-a piping with engineered polymer (EP) or lead-free brass ASTM F1960 cold expansion fittings, or lead-free brass compression fittings complying with ASTM F1960, or ASTM F1807, metal insert and copper crimp rings.

a. PEX-a piping shall only be used on NPS 2 and smaller

D. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Drawn-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed or soldered joints, or copper pressure-seal fittings and pressure-sealed joints.

2. PEX-a piping with engineered polymer (EP) or lead-free brass ASTM F1960 cold expansion fittings, or lead-free brass compression fittings complying with ASTM F1960, or ASTM F1807, metal insert and copper crimp rings.

    a. PEX piping shall not be used in locations where it is exposed to view in an occupiable space such as open to structure rooms. Only storage and mechanical rooms are acceptable locations for exposed to view PEX piping.

3. CPVC, Schedule 40, Schedule 80; socket fittings; and solvent-cemented joints.
4. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Drawn-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed joints, or copper pressure-seal fittings and pressure-sealed joints.
2. CPVC, Schedule 40, Schedule 80; socket fittings; and solvent-cemented joints.
3. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install valves according to the following:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.14 "Check Valves for Plumbing Piping."
3. Section 220523.15 "Gate Valves for Plumbing Piping."

C. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

D. Install domestic water piping level without pitch and plumb.

E. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

I. Install piping to permit valve servicing.

J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Install PEX tubing with loop at each change of direction of more than 90 degrees.

N. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

O. Install thermostats in hot-water circulation piping.

P. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.

G. Joints for PEX Tubing, ASTM: Join according to ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.

H. Joints for PEX Tubing, ASSE: Join according to ASSE 1061 for push-fit fittings.

I. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

J. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M.

3.4 INSTALLATION OF TRANSITION FITTINGS

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Aboveground Domestic Water Piping NPS 2and Smaller: Plastic-to-metal transition fittings or unions.

3.5 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2and Smaller: Use dielectric couplings.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4Use dielectric flange kits.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install hangers for copper piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Install vinyl-coated hangers for PEX and CPVC pipe, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inchesof each fitting.

E. Support vertical runs of copper piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support vertical runs of PEX, and CPVC to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections, and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
b. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
c. Upon completion of a section or of the entire hot and cold-water supply system, the system shall be tested with water or air. Leave pipes to be tested uncovered and unconcealed until it has been tested and approved. The water test pressure shall be 50 psi (345 kPa) above operating pressure but not to exceed the pressure rating of the piping system materials. The air test pressure shall be a minimum of 50 psi (345 kPa) total. Plastic pipe shall not be tested with air except PEX, PP, or PE-RT where permitted by the manufacturer. The piping system shall withstand the test pressure without showing evidence of leakage for a period of not less than 4 hours. Repair leaks/defects and prepare reports as the specs currently state. Leaks and loss in test pressure constitute defects that must be repaired.
d. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
e. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppmof chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppmof chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Water pressure-reducing valves.
3. Balancing valves.
4. Temperature-actuated, water mixing valves.
5. Strainers for domestic water piping.
6. Outlet boxes.
7. Hose bibbs.
8. Water-hammer arresters.
9. Trap-seal primer systems.
10. Flexible connectors.
11. Flow meters.

B. Related Requirements:

1. Section 220519 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gauges, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.

1.2 DEFINITIONS

A. AMI: Advanced Metering Infrastructure.

B. AMR: Automatic Meter Reading.

C. FKM: A family of fluroelastomer materials defined by ASTM D1418.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Test and inspection reports.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psigunless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Apollo Flow Controls; Conbraco Industries, Inc.
    b. Watts.
    c. Zurn Industries, LLC

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Watts.
c. Zurn Industries, LLC

2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.
b. FEBCO; SPX Valves & Controls.
c. Watts Industries, Inc.; Water Products Div.
d. Zurn Plumbing Products Group; Wilkins Div

2. Standard: ASSE 1013
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.
5. Body: Bronze for NPS 2 and smaller; Cast-Iron with interior lining that complies with AWWA C550 or that is FDA approved or for NPS 2-1/2 and larger, steel with interior lining that complies with AWWA C550 or that is FDA approved.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:

a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet
b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet
c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.5 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Bell & Gossett.
b. Watts.
c. Armstrong
d. NIBCO, Inc.

2. Type: Ball valve with two readout ports and memory-setting indicator.
3. Body: Brass.
4. Size: Same as connected piping, but not larger than NPS 2
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Manifold, Thermostatic, Water Mixing Valve Assemblies, TMV-1:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Acorn.
    b. Lawler.
    c. Leonard

2. Description: Factory-fabricated, exposed-mounted, thermostatically controlled, water mixing valve assembly in two-valve parallel arrangement.
3. Large-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gauges on inlet and outlet.
4. Tempered-Water Setting: 110 deg F.
5. Unit Tempered-Water Design Flow Rate: 40 gpm.
6. Unit Minimum Tempered-Water Design Flow Rate: 0.25 gpm.
7. Selected Unit Flow Rate at 45-psigPressure Drop: 5 gpm.
8. Unit Pressure Drop at Design Flow Rate: 5 ft.w.c.
9. Unit Tempered-Water Outlet Size: 1-1/4-inch NPS end connection.
10. Unit Hot- and Cold-Water Inlet Size: 1-inch NPS end connections.
11. Thermostatic Mixing Valve and Water Regulator Finish: Chrome plated.
12. Piping Finish: Copper.

B. Individual-Fixture, Water Tempering Valves

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Honeywell Water Controls
    b. Lawler Manufacturing Company, Inc
    c. Leonard Valve Company
    d. Powers; a Watts Industries Co
    e. Watts Industries, Inc.; Water Products Div
    f. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1016, thermostatically controlled, water tempering valve
3. Pressure Rating: 125 psig min. unless otherwise indicated
4. Body: Bronze body with corrosion-resistant interior components
5. Temperature control: Adjustable.
6. Inlet and Outlet: Threaded

7. Finish: Rough or chrome-plated bronze

2.7 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psigminimum unless otherwise indicated.
2. Body: Bronze for NPS 2and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2and larger.
3. End Connections: Threaded for NPS 2and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2and Smaller: 0.020 inch.
    b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.

6. Drain: Pipe plug.

2.8 OUTLET BOXES

A. Outlet Boxes, EC-1:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Guy Gray, IPS Corporation.
    b. Water-Tite, IPS Corporation.

2. Mounting: Recessed.
3. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
4. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Accessory: Water hammer arresters.
6. Supply Shutoff Fittings: NPS 1/2gate, globe, or ball valves and NPS 1/2copper, water tubing.

2.9 HOSE BIBBS

A. Hose Bibbs HB-1:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Jay R Smith Mfg Co.

b. MIFAB, Inc.
c. Watts.
d. Zurn.

2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 1/2 or NPS 3/4threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig
8. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Service Areas: Chrome or nickel plated.
11. Finish for Finished Rooms: Chrome or nickel plated.
12. Operation for Service Areas: Operating key.
13. Include operating key with each operating-key hose bibb.
14. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.10 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. JR Smith.
b. Precision Plumbing Products.
c. Zurn Industries, LLC.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.11 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems TP-1, TP-2:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Precision Plumbing Products.
b. MIFAB.

2. Standard: ASSE 1044.
3. Inlet Size: NPS 3/4, ASTM B88, Type L; copper, water tubing.

4. Cabinet: Recessed-mounted steel box with stainless steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120 V ac power.

    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: Four (TP-1) and Eight (TP-2).
8. Size Outlets: NPS 1/2.

2.12 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2and Larger: Flanged copper alloy.

2.13 WATER FLOW METERS

A. Turbine-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Badger Meter

2. Standard: AWWA C701.
3. Pressure Rating: 150 psigworking pressure.
4. Body Design: Turbine; totalization meter.
5. Registration: In gallonsor cubic feetas required by the owner.
6. Case: Bronze.

B. End Connections: Threaded or flanged.

C. Ultrasonic-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Badger Meter

2. Standard: Applicable portions of AWWA C700.
3. Pressure Rating: 150 psigworking pressure.

4. Body Design: Ultrasonic open flow tube; totalization meter.
5. Registration: In gallonsor cubic feetas required by the owner.
6. Case: Epoxy-coated ductile iron.
7. End Connections: Threaded or flanged.

2.14 SEISMIC JOINTS

1. Available manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

    a. Metraflex

2. Seismic Rating: Required
3. Construction: Two flexible sections of stainless steel hose and braid, two 45° elbows and a 90° elbow. Factory supplied center support, drain/air release plug
4. Minimum movement: 3” +/- in all directions
5.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

A. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

B. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

C. Y-Pattern Strainers: For water, install on supply side of each water pressure-reducing valve.

D. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 1-1/2-by-3-1/2-inchfire-retardant-treated-wood blocking, wall reinforcement between studs.

E. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

F. Trap-Seal Primer Systems: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

A. Connect control wiring in accordance with Division 26 electrical specifications.

3.5 IDENTIFICATION

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Vacuum breakers.
2. Balancing valves.
3. Temperature-actuated, water mixing valves.
4. Outlet boxes.
5. Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections.

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 221119

SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. In-line, sealless centrifugal pumps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which pumps will be attached.
2. Size and location of initial access modules for acoustical tile.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: UL 778 for motor-operated water pumps.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, seal less, overhung-impeller centrifugal pumps.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bell and Gossett Domestic Pump; ITT Industries.
2. Grundfos Pumps Corp.

C. Capacities and Characteristics:

1. See Drawings.

D. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Minimum Working Pressure: 125 psig.
3. Maximum Continuous Operating Temperature: 220 deg F.
4. Casing: Bronze, with threaded or companion-flange connections.
5. Impeller: composite or stainless steel.
6. Motor: Single speed.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

A. As indicated on drawings and sequence of operations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 PUMP INSTALLATION

A. Mount pumps in orientation complying with manufacturer's written instructions.

B. Pump Mounting:

1. As indicated on Structural and Plumbing Drawings.

C. Install thermostats in hot-water return piping.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.

C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, separately coupled centrifugal pumps.
b. Horizontally mounted, in-line, close-coupled centrifugal pumps.
c. Vertically mounted, in-line, close-coupled centrifugal pumps.
d. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping.

Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in the following:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.14 "Check Valves for Plumbing Piping."
3. Install pressure gauge and snubber at suction of each pump and pressure gauge and snubber at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

C. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set pressure switches, thermostats, timers, and time-delay relays for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.8 ADJUSTING

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 221123.21

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hubless, cast-iron soil pipe and fittings.
2. Copper tube and fittings.
3. ABS pipe and fittings.
4. Specialty pipe fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Field quality-control reports.

1.4 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10 ft. head of water.
2. Waste, Force-Main Piping: 50 psig.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AB&I Foundry.
2. Charlotte Pipe.
3. Tyler Pipe.

B. Pipe and Fittings:

1. Marked with CISPI collective trademark.
2. ASTM A888 or CISPI 301.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. AB&I Foundry.
b. ANACO-Husky.
c. Charlotte Pipe.
d. Tyler Pipe.

2. Standards: ASTM C1277 and ASTM C1540.
3. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.4 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Copper Tube, Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, manufacturer shall be the following.

a. a. Viega LLC, ProPress

2. Source Limitations: Obtain pressure-seal-joint fittings, copper or bronze, from single manufacturer.
3. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.

4. Tools: Manufacturer's specific tools intended for the application of pressure seal fittings of the correct size.
5. Minimum 200-psigworking-pressure rating at 250 deg F.

D. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

E. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.5 ABS PIPE AND FITTINGS

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. AB&I Foundry.
b. ANACO-Husky.
c. Charlotte Pipe.
d. Tyler Pipe.

B. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.

C. Cellular-Core ABS Pipe: ASTM F628, Schedule 40.

D. ABS Socket Fittings: ASTM D2661, made in accordance with ASTM D3311, drain, waste, and vent patterns.

E. Solvent Cement: ASTM D2235.

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Non-pressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Dallas Specialty & Mfg Co.
2) Fernco Inc.
3) Mission Rubber Co.

b. Standard: ASTM C1173.
c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.
e. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Cascade Waterworks, Mfg Co.
2) Mission Rubber Co.

b. Standard: ASTM C1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Capitol Mfgr Co.
2) Watts.
3) Wilkins.
4) Zurn.

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 125 psigminimum at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Capitol Mfgr Co.
2) Watts.
3) Zurn.

b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 125 psigminimum at 180 deg F.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Advance Products & Systems.
2) Calpico, Inc.
3) Central Plastics Company.

b. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Anvil International.
2) Precision Plumbing Products.

3) Victaulic Company.

b. Description:

1) Standard: IAPMO PS 66.
2) Electroplated steel nipple.
3) Pressure Rating: 300 psigat 225 deg F.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31200 “Earth Moving”

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back-to-back or side by side with common drain pipe.

    a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4and larger.
2. Horizontal Sanitary Waste Piping: Two percent downward in direction of flow.
3. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

O. Install aboveground ABS piping in accordance with ASTM D2661.

P. Install underground ABS piping in accordance with ASTM D2321.

Q. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

    a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
    b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.

C. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

D. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
b. Provide rigid sway bracing for pipe and fittings 4 inchesand larger, upstream and downstream of all changes in direction 45 degrees and greater.
c. Provide rigid sway bracing for pipe and fittings 5 inchesand larger, upstream and downstream of all changes in direction and branch openings.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

    a. NPS 1-1/2and Smaller: Fitting-type transition couplings.
    b. NPS 2and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS: Use dielectric flanges, flange kits or nipples.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" and Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment".

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42 clamps.
4. Install individual, straight, horizontal piping runs:

    a. 100 Ft.and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Ft.: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Ft.if Indicated: MSS Type 49, spring cushion rolls.

5. Multiple, Straight, Horizontal Piping Runs 100 Ft.or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52 spring hangers.

B. Install hangers for cast-iron and copper soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Install hangers for ABS piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping and tubing within 12 inchesof each fitting and coupling.

E. Support vertical runs of cast-iron and copper soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support vertical runs of ABS piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
6. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2and larger.

D. Where installing piping adjacent to equipment allow space for service and maintenance of equipment.

E. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping NPS 2and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in. Upon completion of a section or of the entire system, the system shall be tested with water or air. Leave pipes to be tested uncovered and unconcealed until it has been tested and approved.

a. Option 1 Water Test:

1) Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water.
2) The water level must not drop for 15 minutes from inspection start to completion of inspection.
3) Drop in water level constitute defects that must be repaired.
4) Repair leaks/defects and prepare reports as the specs currently state.

b. Option 2 Water Test:

1) Close openings in piping system and fill with water up to a pressure that shall be 50 psi (345 kPa) above operating pressure but not to exceed the pressure rating of the piping system materials.
2) The piping system shall withstand the test pressure without showing evidence of leakage for a period of not less than 4 hours.
3) Repair leaks/defects and prepare reports as the specs currently state.
4) Leaks and loss in test pressure constitute defects that must be repaired.

c. Option 3 Air Test:

1) Close openings in piping system and fill with air up to a pressure that shall be a minimum of 50 psi (345 kPa) total. Plastic pipe shall not be tested with air except PEX, PP, or PE-RT, or where permitted by the manufacturer.
2) The piping system shall withstand the test pressure without showing evidence of leakage for a period of not less than 4 hours.
3) Repair leaks/defects and prepare reports as the specs currently state.
4) Leaks and loss in test pressure constitute defects that must be repaired.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4and smaller are to be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
2. Copper Type DWV tube, copper drainage fittings, and soldered or pressure-sealed joints.
3. Solid-wall or Cellular-core ABS pipe, ABS socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded and Shielded, nonpressure transition couplings.

C. Aboveground, vent piping NPS 4nd smaller is to be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
2. Solid-wall and Cellular-core ABS pipe, ABS socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Unshielded and Shielded, nonpressure transition couplings.

D. Underground, soil, waste, and vent piping NPS 4and smaller are to be any of the following except as noted below:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.
2. Solid-wall and Cellular-core ABS pipe, ABS socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Unshielded and Shielded, nonpressure transition couplings.
4. Where underground waste piping receives discharge from heated food service equipment including warewasher/dishwasher, provide the following for a minimum of 10 feet from receiving drain continuing downstream:

    a. Hubless, cast-iron soil pipe and fittings; heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

1. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashing assemblies.
2. Section 078413 "Penetration Firestopping" for through-penetration firestop assemblies.

1.3 DEFINITIONS

A. ABS: Acrylonitrile butadiene styrene.

B. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show fabrication and installation details for frost-resistant vent terminals.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 CLEANOUTS

A. Cast-Iron Exposed Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Jay R Smith.
b. Josam Company.
c. MIFAB, Inc.
d. Tyler Pipe.
e. Watts.
f. Zurn.

2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: Inside calk.
8. Closure: Cast-iron plug.
9. Adjustable Housing Material: Cast iron with setscrews or other device.
10. Frame and Cover Material and Finish: Painted cast iron.
11. Frame and Cover Shape: Round.
12. Top-Loading Classification: Heavy Duty.
13. Riser: ASTM A74, Extra-Heavy Class, cast-iron drainage pipe fitting and riser to cleanout.

B. **Cast-Iron Exposed Grade/Unfinished Area Cleanouts:**

1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:**

a. **Jay R Smith 4258.**
b. Josam Company.
c. MIFAB, Inc.
d. Tyler Pipe.

e. Watts.
f. Zurn.

2. **Standard: ASME A112.36.2 for heavy-duty, adjustable housing cleanout.**
3. Size: 11” Diameter, oversized to ensure no load transmitted to connected pipes.
4. Type: Heavy-duty, round flanged housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: Inside caulk.
8. Closure: Cast-iron plug.
9. Adjustable Housing Material: Cast iron with setscrews or other device.
10. Frame and Cover Material and Finish: Scoriated cast iron.
11. Frame and Cover Shape: Round.
12. Top-Loading Classification: Heavy Duty.
13. Riser: ASTM A74, Extra-Heavy Class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Jay R Smith.
b. Josam Company.
c. MIFAB, Inc.
d. Tyler Pipe.
e. Watts.
f. Zurn.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:

a. Brass.
b. Countersunk head.
c. Drilled and threaded for cover attachment screw.
d. Size: Same as or not more than one size smaller than cleanout size.

6. Wall Access, Cover Plate: Round, deep, chrome-plated bronze cover plate with screw.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2side inlet.

B. Floor-Drain, Inline Trap Seal:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. Zurn Industries, LLC.

2. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
3. Material: Polymer.
4. Standard: Tested and certified in accordance with ASSE 1072.
5. Listing: ICC-ES or IAPMO listed.
6. Size: Same as floor drain outlet or strainer throat.

C. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

D. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inchenclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feetfor piping NPS 4 and smaller piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

E. Install floor-drain inline trap seals to clean surface free of debris. Install into drain body or strainer throat and fill trap with water and ensure seal opens and seals. Follow all the manufacturer’s instructions for installation.

F. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

G. Install vent caps on each vent pipe passing through roof.

H. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inchclearance between vent pipe and roof substrate.

I. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inchclearance between vent pipe and roof substrate.

J. Install wood-blocking reinforcement for wall-mounting-type specialties.

K. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221319.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Floor drains.
2. Floor sinks.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains, FD-1:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Jay R Smith.
b. Josam Company.

c. MIFAB.
d. Watts.
e. Zurn.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Epoxy coated cast iron.
5. Primary, Secondary weepholes.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Backwater Valve: Not required.
10. Sediment Bucket: Not required.
11. Top or Strainer Material: Nickel bronze.
12. Top of Body and Strainer Finish: Nickel bronze.
13. Top Shape: Square.
14. Dimensions of Top or Strainer: adjustable, heel-proof.
15. Top Loading Classification: Heavy Duty.
16. Funnel: Not required.
17. Inlet Fitting: trap-seal primer valve connection.
18. Trap Material: Cast iron
19. Trap Pattern: Standard P-trap.
20. Trap Features: Trap-seal primer valve drain connection.

2.3 FLOOR SINKS

A. Stainless-Steel Floor Sinks, ASME A112.6.7, FS-1:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Jay R Smith.
b. Josam Company.
c. MIFAB.
d. Watts.
e. Zurn.

2. Standard: ASME A112.6.7.
3. Pattern: Funnel floor drain.
4. Body Material: Stainless steel.
5. Anchor Flange: Not required.
6. Clamping Device: Not required.
7. Outlet: Bottom, no-hub connection.
8. Sediment Bucket: Not required.
9. Internal Strainer: Dome.
10. Internal Strainer Material: Stainless steel.
11. Top Grate Material: Stainless steel, loose.
12. Top of Body and Grate Finish: Stainless steel.

13. Top Shape: Square.
14. Dimensions of Top Grate: ½ grate.
15. Top Loading Classification: No traffic.
16. Funnel: Required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inchesor Less: Equivalent to 1 percent slope, but not less than 1/4-inchtotal depression.
    b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    c. Radius, 60 Inchesor Larger: Equivalent to 1 percent slope, but not greater than 1-inchtotal depression.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

    a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Install piping adjacent to equipment to allow service and maintenance.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319.13

SECTION 221323 - SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Grease interceptors.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. PP: Polypropylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of concrete interceptor indicated. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

B. Shop Drawings: For each type and size of precast-concrete interceptor indicated.

1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, based on input from Installers of the items involved:

1. Interceptors.
2. Piping connections. Include size, location, and elevation of each.
3. Interface with underground structures and utility services.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:

1. Notify Architect and Owner no fewer than seven days in advance of proposed interruption of service.
2. Do not proceed with interruption of sewer services without Architect's and Owner's written permission.

PART 2 - PRODUCTS

2.1 GREASE INTERCEPTORS

A. Grease Interceptors, GI-1:

a. Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1) Green Turtle Americas Ltd.
2) Zurn Plumbing Products Group.

2. Include accessways, tanks, and piping and baffle openings to retain grease and solids and to permit tangential laminar wastewater flow.
3. Factory installed schedule 40 PVC cement welded type socket ports, or straight pipe, fitted into interceptor walls for each pipe connection.
4. Accessway Frames and Covers: Round cover with non-slip cover finish, gasketed and non-vented top design with “Grease Interceptor” lettering cast into cover.
5. Cast Iron: AASHTO M306 Traffic load rated. 24-inch diameter cover with 0.25” gasket. Two closed pickholes. Non-Bolted or Bolted. Weight 249 lbs.
6. Watertight Flexible Caulking: Sikaflex 255 or Sikaflex 221 or approved alternate to provide watertight seal at extension collar joints.
7. Structural Design Loads:

a. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).

8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into interceptor walls, for each pipe connection.
9. Capacities and Characteristics: As indicated.

B. Accessories:

C.

1. Manhole Frames and Covers: Ferrous; 24-inchID by 7- to 9-inchriser with 4-inch-minimum width flange and 26-inch-diameter cover.

a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
b. Include indented top design with lettering cast into cover, using wording equivalent to “GSHP MANIFOLD”.
c. Capacities and Characteristics: As indicated.

2. Precast-Concrete Manhole Risers: ASTM C 478, with rubber-gasket joints.

a. Structural Design Loads:

1) Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).

b. Length: From top of underground concrete structure to grade.
c. Riser Sections: 3-inch minimum thickness and 36-inch diameter.
d. Top Section: Eccentric cone, unless otherwise indicated. Include top of cone to match grade ring size.
e. Gaskets: ASTM C 443, rubber.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified Geotechnical Report

3.2 INSTALLATION

A. Install precast-concrete interceptors according to ASTM C 891. Set level and plumb.

B. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

C. Set tops of manhole frames and covers flush with finished surface in pavements. Set tops 3 inchesabove finish surface elsewhere, unless otherwise indicated.

D. Set tops of grating frames and grates flush with finished surface.

3.3 SOLIDS INTERCEPTORS

A. Set tops of manhole frames and covers flush with finished surface in pavements. Set tops 3 inchesabove finish surface elsewhere, unless otherwise indicated.

B. Set tops of grating frames and grates flush with finished surface.

3.4 CONNECTIONS

A. Piping installation requirements are specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

3.5 IDENTIFICATION

A. Identification materials and installation are specified Geotechnical Report Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.

1. Use warning tapes or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.6 COMMISSIONING

A. Commissioning Authority

1. The commissioning authority (CA) has been contracted directly with the owner for this project. The CA has overall responsibility for planning and coordinating the commissioning process. However, commissioning involves all parties involved with the design and construction process, including the mechanical (Division 22 & 23) contractor, and all specialty sub-contractors within Division 23, such as sheet metal, piping, refrigeration, water treatment, TAB and controls, plus major equipment suppliers as required.

END OF SECTION 221323

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Commercial, light-duty, storage, electric, domestic-water heaters.
2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.

B. Product Certificates: For each type of commercial, electric, domestic-water heater.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 WARRANTY

1. Warranty Periods: From date of First Day of Business (FDOB).

    a. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:

        1) Storage Tank: Three years.
        2) Controls and Other Components: one year.

    b. Expansion Tanks: one year.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. A.O. Smith Corporation.
    b. Bradford White Corporation.
    c. State Industries.

2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
3. Standard: UL 174.
4. Storage-Tank Construction: Steel, vertical arrangement.

    a. Tappings: ASME B1.20.1 pipe thread.
    b. Pressure Rating: 150 psig.
    c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

5. Factory-Installed, Storage-Tank Appurtenances:

    a. Anode Rod: Replaceable magnesium.
    b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
    c. Drain Valve: Corrosion-resistant metal with hose-end connection.
    d. Insulation: Comply with ASHRAE/IES 90.1.
    e. Jacket: Steel with enameled finish or high-impact composite material.
    f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
    g. Heating Elements: Electric, screw-in immersion type.
    h. Controls shall be capable of integration to BAS/BMS per control drawings.
    i. Temperature Control: Adjustable thermostat.
    j. Safety Control: High-temperature-limit cutoff device or system.
    k. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.

B. Capacity and Characteristics:

1. Capacity: 120 gal.
2. Recovery: 50 gphat 100 deg Ftemperature rise.
3. Temperature Setting: 140 deg F.
4. Power Demand: 12 kW.
5. Heating Elements:

    a. Number of Elements: One.
    b. Kilowatts Each Element: 12 kW.
    c. Number of Stages: One.

6. Electrical Characteristics:

    a. Volts: 480 V.
    b. Phases: Three.
    c. Hertz: 60 Hz.
    d. Full-Load Amperes: 14.8 A.
    e. Minimum Circuit Ampacity: 18.5 A.
    f. Maximum Overcurrent Protection: 20 A.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Bell & Gossett, a Xylem Company.
    b. Amtrol, a Worthington Industries Inc. Company.

2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
3. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
4. Construction:

    a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Air-Charging Valve: Factory installed.

5. Capacity and Characteristics:

    a. Working-Pressure Rating: 150 psig.
    b. Capacity Acceptable: 8 gal. minimum.
    c. Air Precharge Pressure: 40 psi.

B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater and include drain outlet not less than NPS 3/4with ASME B1.20.1 pipe threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.

D. Heat-Trap Fittings: ASHRAE/IES 90.1.

E. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig-maximum outlet pressure unless otherwise indicated.

F. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

G. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.

H. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

I. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

J. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

A. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inchcenters around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping” and Section 220523.15 "Gate Valves for Plumbing Piping."

C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric,

domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

E. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

F. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

G. Fill electric, domestic-water heaters with water.

H. Charge domestic-water expansion tanks with air to required system pressure.

I. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters. Training shall be a minimum of one hour.

END OF SECTION 223300

SECTION 224213.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall-mounted water closets.
2. Flushometer valves.
3. Toilet seats.
4. Supports.

B. Related Requirements:

1.2 DEFINITIONS

A. Standard-Efficiency Flush Volume: 1.6 gal. per flush.

B. High-Efficiency Flush Volume: 1.28 gal. or less per flush.

C. WaterSense Fixture: Water closet and/or flushometer valve/tank certified by the EPA to meet the WaterSense performance criteria.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:

1. Comply with ASME A112.19.2/CSA B45.1 for water closets.
2. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets and tanks.
3. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
4. Comply with IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
5. Comply with ASME A112.6.1M for water-closet supports.
6. Comply with ICC A117.1 for ADA-compliant water closets.
7. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous china water closets to sanitary drainage systems.
8. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous china water closets to sanitary drainage systems.

2.2 WALL-MOUNTED WATER CLOSETS

A. Water Closets - Wall Mounted, Top Spud: WC-1, WC-2 (ADA).

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Sloan.
    b. Toto.

2. Source Limitations: Obtain water closets from single source from single manufacturer.
3. Bowl:

    a. Material: Vitreous china.
    b. Type: Siphon jet.
    c. Style: Flushometer valve.
    d. Mounting Height: Standard (WC-1); ADA compliant (WC-2).
    e. Rim Contour: Elongated.
    f. Water Consumption: 1.1 gal.per flush.
    g. Spud Size and Location: NPS 1-1/2; top.
    h. Color: White.

4. Flushometer Valve:
5. Toilet Seat: white, open front, elongated.
6. Support: Water-closet carrier.

2.3 FLUSHOMETER VALVES

A. Flushometer Valves - Diaphragm, **Manual** Actuated:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Sloan.
    b. Toto.

2. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Style: Exposed.
7. Exposed Flushometer-Valve Finish: Chrome-plated.
8. Actuator: **Side mounted**; ADA Compliant.
9. **Valve: ASSE 1037 and ASME 112.19.2**
10. Trip Mechanism: **Manual activation handle with dual flush volume selection.**
11. Consumption: **dual flush 1.6/1.1** gal.per flush.
12. Minimum Inlet: NPS 1.
13. Minimum Outlet: NPS 1-1/4.

2.4 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Bemis Manufacturing Company.
    b. Zurn.
    c. Toto.

2. Source Limitations: Obtain toilet seat from single source from single manufacturer.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.
10. Surface Treatment: Not required.

2.5 SUPPORTS

A. Water-Closet Carrier:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Jay R Smith.
b. Josam Company.
c. MIFAB, Inc.
d. Watts.
e. Zurn.

2. Source Limitations: Obtain water-closet carrier from single source from single manufacturer.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Water-Closet Installation:

1. Install level and plumb.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.

B. Support Installation:

1. Use carrier supports with waste-fitting assembly and seal.
2. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
3. Measure support height installation from finished floor, not structural floor.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install actuators in locations easily reachable for people with disabilities.
4. Install new batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allowing space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inchhigh.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Division 26 and electrical engineering drawings/specifications.

3.6 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.7 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.13

SECTION 224216.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vitreous-china, counter-mounted lavatories.
2. Automatically operated lavatory faucets.
3. Supply fittings.
4. Waste fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments of automatic faucets.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

A. Lavatory - Oval, Vitreous China, Undercounter Mounted, L-1:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. American Standard.
b. Kohler.
c. Toto

2. Fixture:

a. Standard: ASME A112.19.2/CSA B45.1.
b. Type: For undercounter mounting.
c. Nominal Size: Oval, 19 by 16 inches.
d. Faucet-Hole Punching: No holes.
e. Faucet-Hole Location: On countertop.
f. Color: White.
g. Mounting Material: Sealant and undercounter mounting kit.

3. Faucet: Automatically Operated Lavatory Faucet.

2.2 AUTOMATICALLY OPERATED LAVATORY FAUCETS

A. Lavatory faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372, or be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI) accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Lavatory Faucets - Automatic Type: Battery Powered Electronic Sensor Operated, Mixing:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Toto.
b. Kohler.
c. Sloan.

2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.

3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
5. Body Type: Single hole.
6. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 0.5 gpm.
9. Mounting Type: Deck, concealed.
10. Spout: Rigid type.
11. Spout Outlet: Aerator.
12. Drain: Not part of faucet.

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type, or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:

1. NPS 1/2.
2. ASME A112.18.6/CSA B125.6, braided- or corrugated-stainless steel, flexible hose riser.

2.4 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2 by NPS 1-1/4.
2. Material:

a. Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated, brass or steel wall flange.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install lavatories level and plumb in accordance with roughing-in drawings.

B. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

C. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

D. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inchhigh.

3.5 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.6 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.13

SECTION 224216.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Service sinks.
2. Kitchen/utility sinks.
3. Manually operated sink faucets.
4. Automatically operated sink faucets.
5. Supply fittings.
6. Waste fittings.
7. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
2. Include rated capacities, operating characteristics**,** electrical characteristics**,** and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted sinks.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sinks and faucets to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments for automatic faucets.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 SERVICE SINKS

A. Service Sinks - Molded Stone, Floor Mounted: MS-1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. E.L. Mustee, and Sons.

2. Source Limitations: Obtain sinks from single source from single manufacturer.
3. Fixture:

a. Standard: ASME A112.18.2/CSA B125.2.
b. Shape: Square.
c. Nominal Size: 24 by 24 inches.
d. Height: 10 inches.
e. Rim Guard: On all top surfaces.
f. Color: white.
g. Drain: Grid with NPS 3outlet.

4. Mounting: On floor and flush to wall.
5. Faucet: manual, wall mount, with brace and pail hook.

2.2 KITCHEN/UTILITY SINKS

A. Kitchen/Utility Sinks - Stainless Steel, Counter Mounted: S-1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elkay.

2. Source Limitations: Obtain sinks from single source from single manufacturer.
3. Fixture:

a. Standard: ASME A112.19.3/CSA B45.4.

b. Type: Stainless steel, self-rimming, sound-deadened unit less ledge back.
c. Number of Compartments: One.
d. Overall Dimensions: 14 inches x 18-1/2-inch x 4-3/8 inch.
e. Material: 18-gage, Type 304 stainless steel.
f. Compartment:

1) Bowl Dimensions: 11-1/2 inches x 16 inches 4-3/8 inches.
2) Drain: Grid with NPS 1-1/2tailpiece and twist drain.
3) Drain Location: Rear center.
4) Depth: Wheelchair accessible.

4. Faucet: touchless gooseneck faucet with pull-down sprayhead.

a. Number Required: One.
b. Mounting: On ledge.

5. Supply Fittings:

a. Standard: ASME A112.18.1/CSA B125.1.
b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.

1) Operation: Loose key.
2) Risers: NPS 1/2, ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.

6. Waste Fittings:

a. Standard: ASME A112.18.2/CSA B125.2.
b. Trap(s):

1) Size: NPS 1-1/2.
2) Material:

a) Chrome-plated, two-piece, cast-brass trap, and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

7. Mounting: On counter with sealant.

2.3 MANUALLY OPERATED SINK FAUCETS

A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Commercial Service Sink Faucets - Manual Type: For MS-1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Chicago Faucet Co.
    b. Kohler.

2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Description: Wall/back mounted, brass body, with integral service stops, checks, spout with bucket/pail hook, 3/4-inchhose thread end, integral vacuum breaker, inlets 8 incheso.c., and two-handle mixing.
4. Faucet:

    a. Standards:

        1) ASME A112.18.1/CSA B125.1.
        2) NSF 61 and NSF 372.
        3) ICC A117.1.
        4) ASSE 1001 (VB).

    b. Finish: Polished chrome plated.
    c. Handles: 4-inchwrist blade.
    d. Cartridges: One-fourth turn Ceramic.
    e. Brace: Adjustable top brace.

2.4 AUTOMATICALLY OPERATED SINK FAUCETS

A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Commercial Sink Faucets - Automatic Type: Hard-wired, electronic-sensor-operated, mixing, For S-1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Chicago Faucet.
    b. Kohler.

2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
6. Body Type: Single hole.

7. Body Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.
8. Finish: Polished chrome plate.
9. Handles: Single lever.
10. Maximum Flow Rate: 1.25gpm.
11. Mounting Type: Deck.
12. Spout Type: Rigid, gooseneck, with pull-down sprayhead.
13. Spout Outlet: Spray.
14. Thermostatic Mixing Valve: Below deck, with check valves.
15. Control Module: Below deck, water-resistant module with internal flow setting switches.
16. Drain: Not part of faucet.

2.5 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type, or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:

1. NPS 1/2.
2. ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.

2.6 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2.
2. Material:

a. Chrome-plated, two-piece, cast-brass trap, and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

2.7 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000 psi,28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install sinks level and plumb in accordance with rough-in drawings.

B. Set floor-mounted sinks in leveling bed of cement grout.

C. Install water-supply piping with stop on each supply to each sink faucet.

1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
2. Install stops in locations where they can be easily reached for operation.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inchhigh.

3.5 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.6 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.16

SECTION 224223 - COMMERCIAL SHOWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Shower heads and shower valves.
2. Shower Basin drains.
3. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for showers and basins.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For shower valves to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Shower Valve Washers and O-Rings: Equal to **10** percent of amount of each type and size installed.
2. Shower Valve Cartridges and O-Rings: Equal to **5** percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Shower valves intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 SHOWER HEADS AND SHOWER VALVES

A. Shower Head with Single-Handle, Pressure-Balanced Mixing Valve: SH-1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kohler.

2. Source Limitations: Obtain shower heads and shower valves from single source from single manufacturer.
3. Description: Single-handle, accessible, pressure-balance mixing valve with hot- and cold-water indicators; diverting valve check stops; and hose with handheld shower head on sliding rod shower head.
4. Shower Valve:

a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016/ASME A112.1016/CSA B125.16.
b. Body Material: Solid brass.
c. Finish: Polished chrome plate.
d. Mounting: Exposed.
e. Operation: Single-handle, twist or rotate control.
f. Antiscald Device: Integral with mixing valve.
g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

5. Supply Connections: NPS 1/2.
6. Shower Head:

a. Standard: ASME A112.18.1/CSA B125.1.
b. Wall mount Type: Integral with mounting flange. (Bricor)
c. Handheld showerhead attachment: Hand shower with thumb-tab spay selector.
d. Shower Head Maximum Flow Rate: 1.25 gpm.
e. Shower Head Material: Metallic with chrome-plated finish.
f. Spray Pattern: Adjustable.
g. Integral Volume Control: Required.
h. Temperature Indicator: Integral with shower valve.

2.3 SHOWER BASIN DRAINS

A. Basin Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Zurn.
b. JR Smith.
c. Kohler.

2. Source Limitations: Obtain shower basin drains from single source from single manufacturer.
3. Shower Basin: By others; see architectural plans.
4. Description: Floor drain for concrete/tile shower pan. 6-1/2-inch diameter ABS body, beveled clamp collar and head assembly.
5. Outlet: Drain with NPS 2outlet; lip drain outside shower in accordance with the ADA.

2.4 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000 psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.

B. Examine walls and floors for suitable conditions where showers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install ball valves in water-supply piping to the shower if supply stops are specified with the shower valve. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" Install valves in locations that are accessible for ease of operation.

B. Install shower flow-control fittings with specified maximum flow rates in shower arms.

C. Set shower receptors in leveling bed of cement grout.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with traps and soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.

B. Adjust water pressure at shower valves to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of showers, inspect and repair damaged finishes.

B. Clean shower valves, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed fixtures and fittings.

D. Do not allow use of showers for temporary facilities unless approved in writing by Owner.

END OF SECTION 224223

SECTION 224713 - DRINKING FOUNTAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Drinking fountains.
2. Bottle filling stations.
3. Supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of drinking fountain and bottle filling station.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include diagrams for power wiring.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For drinking fountains with bottle filling stations to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filter Cartridges: No fewer than two of each for each size and type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:

1. Drinking fountains and bottle filling stations intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
2. Comply with ASME A112.19.3/CSA B45.4 for stainless steel drinking fountains and bottle filling stations**.**
3. Comply with NSF 42 and NSF 53 for water filters for drinking fountains and bottle filling stations.
4. Comply with ICC A117.1 for accessible drinking fountains and bottle filling stations.

2.2 DRINKING FOUNTAINS

A. Drinking Fountains - Surface Wall-Mounted, Stainless Steel: DF-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Elkay.
    b. Haws.

2. Source Limitations: Obtain surface wall-mounted, stainless steel drinking fountains from single source from single manufacturer.
3. Type: Vandal resistant.
4. Receptor(s):

    a. Type: On horizontal support.
    b. Shape: Rectangular.
    c. Bubblers: One for each receptor, with adjustable stream regulator, located on deck.
    d. Drain: Grid type with NPS 1-1/4tailpiece.

5. Maximum Water Flow: 0.5 gpm.
6. Control: Push bar.
7. Supply: NPS 3/8with shutoff valve.
8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4chrome-plated brass P-trap and waste.
9. Filter: One or more water filters with capacity sized for unit peak flow rate.
10. Electrical Characteristics:

    a. Volts: 120 V ac.
    b. Phase: Single.

c. Hertz: 60 Hz.

11. Support: Provide manufacturer's mounting plate drinking fountain carrier.
12. Drinking Fountain Mounting Height: High/low - standard/accessible in accordance with ICC A117.1.
13. Bottle Filler: Sensor activation. Fill rate 0.5 to 1.5 gpm.

2.3 SUPPORTS

A. Drinking Fountain Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elkay.

2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping."

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplates to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inchhigh.

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

3.6 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

END OF SECTION 224713

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed controller

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

1. Wiring Diagrams: For power, signal, and control wiring

C. Field quality-control reports

D. Operations and maintenance data.

1.5 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers
2. Torque, speed and horsepower requirement of the load
3. Ratings and characteristics of supply circuit and required control sequence
4. Ambient and environmental conditions of installation location

B. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.6 QUALITY ASSURANCE

A. Electrical components, devices and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application

B. Comply with NFPA 70

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feetabove sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

3.1 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

C. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

D. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

E. Comply with NECA 1.

F. Unless otherwise specified, motor controllers for all motors shall be provided by mechanical contractor.

3.2 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 23 Section "Identification for HVAC Piping and Equipment."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Division 26.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

D. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers at 80 percent.

3.5 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

3.7 COMMISSIONING

A. The equipment and systems referenced in this section are to be commissioned per Section 019113 – General Commissioning Requirements and Section 230800 – Commissioning of HVAC. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

3.8

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves without waterstop.
2. Sleeves with waterstop.
3. Stack-sleeve fittings.
4. Sleeve-seal systems.
5. Grout.
6. Silicone sealants.

1.2 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES WITHOUT WATERSTOP

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends.

B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot dip galvanized, with plain ends.

C. Steel Sheet Sleeves: ASTM A653/A653M, 0.0239-inchminimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 SLEEVES WITH WATERSTOP

A. Description: Manufactured PVC/HDPE or steel, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

2.3 STACK-SLEEVE FITTINGS

A. Description: Manufactured, galvanized cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.4 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Designed to form a hydrostatic seal of 20 psig
2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 coating of length required to secure pressure plates to sealing elements.

2.5 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000 psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.6 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

1. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

B. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inchannular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inchesabove finished floor level.

3. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inchannular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout or silicone sealant, seal space around outside of sleeves.

3.3 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inchannular clear space between sleeve and pipe or pipe insulation.

2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 3 inchesabove finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
2. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

3.6 SLEEVE SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inchannular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

    a. Sleeves with waterstops.

        1) Select sleeve size to allow for 1-inchannular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

    a. Sleeves with waterstops or stack-sleeve fittings.

4. Interior Walls and Partitions:

    a. Sleeves without waterstops.

END OF SECTION 230517

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal hanger-shield inserts.
5. Fastener systems.
6. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 238129 “Variable Refrigerant Flow HVAC Systems” for additional requirements.

1.3 ACTION SUBMITTALS

A. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Equipment supports.

B. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. B-line, an Eaton business.
   b. Thomas & Betts Corporation; A Member of the ABB Group.
   c. Unistrut; Part of Atkore International.

2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with inturned lips.
5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.5 THERMAL HANGER-SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. ERICO International Corporation.
3. Pipe Shields Inc.
4. Rilco Manufacturing Co., Inc.
5. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B-line, an Eaton business.
b. Empire Tool and Manufacturing Co., Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
e. MKT Fastening, LLC.

2. Indoor Applications: Zinc-coated steel.
3. Outdoor Applications: Stainless steel.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.8 MATERIALS

A. Aluminum: ASTM B 221.

B. Carbon Steel: ASTM A 1011/A 1011M.

C. Structural Steel: ASTM A 36/A 36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A 240/A 240M.

E. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 099123 "Interior Painting."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal hanger-shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.

c. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.

N. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Open-spring isolators.
4. Resilient pipe guides.
5. Spring hangers.
6. Restraints - rigid type.
7. Restraints - cable type.
8. Restraint accessories.

B. Related Requirements:

1. Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

1.3 DEFINITIONS

A. IBC: International Building Code.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-force-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device component.
4. Annotate to indicate application of each product submitted and compliance with requirements.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. Include design calculations and details for selecting vibration complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and basis for approval (tests or calculations).
3. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
4. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design system.

B. Consequential Damage: Provide additional restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7-05 so that failure of a non-essential or essential HVAC component will not cause the failure of any other essential architectural, mechanical, or electrical building component.

C. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723 and be so labeled.

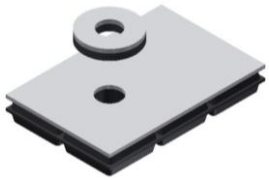
D. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.2 VIBRATION ISOLATORS

A. Elastomeric Isolation Pads, IP-1: Neoprene rubber waffle pad with steel plate and washer for bolt attachment to equipment. Includes friction pad. Neoprene size and durometer shall meet the recommended load per area for the unit to be supported. Consult manufacturer for recommended durometer of neoprene pad.

1. Mason Industries MBSW.
2. Approved equivalent.

a. 

3. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
4. Size: Factory or field cut to match requirements of supported equipment.
5. Minimum deflection as indicated on Drawings/Specifications.
6. Pad Material: Oil- and water-resistant rubber/neoprene
7. Load-bearing metal plates adhered to pads.

B. Double Deflection Neoprene Mount, Type N-5: Neoprene mounting with a minimum static deflection of 0.35 inches. All metal surfaces are neoprene-covered to prevent corrosion and have friction pads, both top and bottom. Provide bolt holes on the bottom and a tapped hole with cap screw and washer on top.

1. Mason Industries type ND.
2. Or approved equivalent.

3.

C. Double-Deflection Spring Hangers, Type SH-1: Vibration hangers shall contain a steel spring and 0.3-inch deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection. Submittals shall include a scale drawing of the hanger showing misalignment capability.

1. Mason Industries type 30N
2. Or approved equivalent.
3.

D. Neoprene or Fiberglass Hangers, Type SH-3: Cone-shaped elastomeric mounting made from neoprene with a steel box frame, open on two sides, containing a double deflection neoprene element with a projecting bushing to prevent steel to steel contact. Hanger rod shall penetrate neoprene element and steel frame with sufficient clearance to allow it to swing through a 30-degree arc before contacting neoprene bushing at the perimeter of the lower hole in the frame. Hole in top of box frame for bolting to structure.

1. Mason Industries type HD
2. Or approved equivalent.
3.

2.3 FLEXIBLE CONNECTORS

A. Flexible Duct Connector, Type FC-1: Flexible glass fabric double coated with neoprene. Air-tight, water-tight, and fire-retardant.

1. Ventfabrics type Ventglas.
2. Duro-Dyne type MFN or MF6N.
3. Or approved equivalent.

2.4 ISOLATOR ACCESSORIES

A. Cushion Sleeve: Neoprene pad 1/4-inch minimum thickness for use as a noise and vibration isolator between piping and its supporting or suspension system. Sleeve shall be split or hinged and shall have an exterior metal shell to prevent crushing during installation.

1. Mason Industries Type SWS.
2. Or approved equivalent.

B. Acoustical Insulation: 1/2- to 6-inch-thick low density unfaced fiberglass batts.

1. Owens Corning Standard.
2. Or approved equivalent.

C. Mineral Fiber Insulation: 2- to 3-inch-thick fire-rated mineral fiber insulation batts.

1. USG Thermafiber.
2. Or approved equivalent.

D. Resilient Caulk: Paintable and non-hardening.

1. USG Acoustical Sealant.
2. Pecora Corporation Acoustical Sealant BA098.
3. 3M Vibration Control Systems Fire Stop 2000.

E. Clay Packing: Moldable, non-curing, one component fire-rated putty pads for protection of electrical outlet boxes and reduction of sound transmission.

1. Johns Manville Firetemp Intumescent Putty Pads

F. Resilient Isolation Washer Bushings: To be used such that direct contact between bolt and equipment is eliminated. One-piece, molded, oil- and water-resistant neoprene, with a flat washer face. Manufactured of bridge-bearing neoprene. Maximum loading not to exceed 1000 psi.

2.5 FACTORY FINISHES

A. Where exposed to the atmosphere all steel to be finished with dry powder coating for corrosion protection.

B. All hardware shall be zinc electroplated.

C. Springs and housings shall be powder coated.

2.6 MECHANICAL ANCHOR BOLTS

A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and dynamic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION CONTROL DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.

B. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified

C. Install all vibration isolators in strict accordance with this Specification, the Manufacturer’s instructions, and all certified submittal data.

D. Install vibration isolators so as not to cause any change in position of equipment, piping or ducting which would result in stresses or misalignment.

E. Make no rigid connections between piping and building structure that degrades the noise and vibration systems specified herein.

F. Coordinate work with other trades to avoid rigid contact with the building structure.

G. Bring to the attention of the Architect/Engineer any conflict with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions prior to installation.

H. Bring to the attention of the Architect/Engineer any discrepancies between this Specification and the field conditions prior to installation.

I. Bring to the attention of the Architect/Engineer any conflicts due to specific equipment selection prior to installation.

3.4 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.5 VIBRATION ISOLATION SCHEDULES

A. Schedule.

Equipment	Isolator	Deflection in Inches	Base	Flexible Connector	Notes
DOAS-# / **MAU-#**	IP-1	0.2	--	FC-1	1,2,3,
VAV Boxes (no fans/coils)	--	--	--	FC-1	1,2,
Ceiling Suspended AC-#	SH-3	0.15	--	FC-1	1,2,3,
All suspended fans	SH-3	0.20	--	FC-1	1,2,
CU-# Condensing Units	IP-1	(15%)	--	--	1,3,4

B. Notes:

1. See Mechanical and Structural Drawings.
2. Install flexible duct connectors at the intake and discharge of all ducted units, fans and air handling equipment.
3. All piping attached to unit shall utilize a flexible connector to limit vibration transfer.

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Duct labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve-numbering scheme.

D. Valve Schedules: Provide for each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inchminimum thickness, with predrilled or stamped holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
4. Minimum Letter Size: 1/4 inchfor name of units if viewing distance is less than 24 inches, 1/2 inchfor viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inchthick, with predrilled holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inchfor name of units if viewing distance is less than 24 inches, 1/2 inchfor viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's drawing designation and unique equipment number.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving 1/8 inch, with predrilled holes for attachment hardware.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. Minimum Letter Size: 1/4 inchfor name of units if viewing distance is less than 24 inches, 1/2 inchfor viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless steel rivets or self-taping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA70E and other applicable codes and standards.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inchthick, and having predrilled holes for attachment hardware.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. Minimum Letter Size: 1/4 inchfor name of units if viewing distance is less than 24 inches, 1/2 inchfor viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:

1. Duct size.
2. Flow-Direction Arrows: Include flow-direction arrows on main distribution ducts. Arrows may be either integral with label or may be applied separately.

2.4 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Brady.
2. Craftmark.
3. Seton.

B. Description: Stamped or engraved with 1/2-inchletters and numbers.

1. Tag Material: Brass or aluminum, no. 14 gage thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire, link chain or beaded chain or S-hook.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inchbond paper.

1. Mark valves for emergency shutoff and similar special uses.
2. Include valve-tag schedule in operation and maintenance data.
3. Tabulate all of the following, and include on valve tag, the information indicated below:

a. Building
b. Area/room
c. System abbreviation (include on tag)
d. Valve size
e. Supply or Return or omit if not applicable
f. Normal operating position, open or closed or modulating
g. Valve number (include on tag)
h. Valve type, control, balancing, shut-off, etc.

2.5 WARNING TAGS

A. Description: Preprinted accident-prevention tags of plasticized card stock.

1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of mechanical equipment.

B. Sign and Label Colors:

1. White letters on an black background.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E**,** and other applicable codes and standards.

3.4 INSTALLATION OF DUCT LABELS

A. Install self-adhesive duct labels showing service and flow direction with permanent adhesive on air ducts.

1. Provide labels in the following color codes:

a. For air supply ducts: White letters on blue background.
b. For air return ducts: White letters on blue background.
c. For exhaust-, outside-, relief-, return-, and mixed-air ducts: White letters on blue background.

B. Locate label near each point where ducts enter into and exit from concealed spaces and at maximum intervals of 20 ft.where exposed or are concealed by removable ceiling system.

C. Stenciled Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. Black letters on White background.

3.5 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft.of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

C. Piping less than or equal to 1-1/2 inches in diameter may use 4” x 2” brass identification tag stamped with ½ text.

D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

E. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

F. Pipe-Label Color Schedule:

1. Gravit/Pumped Condensate, Refrigerant Hot Gas/Liquid/Suction: White letters on an ANSI Z535.1 safety-green background.

3.6 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except valves within factory-fabricated equipment units, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1. Valve-Tag Size and Shape:

a. All: 4 by 2 inches recangular

2. Valve-Tag Colors:

a. No color

3.7 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Testing, Adjusting, and Balancing of Air Systems:

    a. Constant-volume air systems.
    b. Variable-air-volume systems.

2. Balancing Domestic Piping Systems:

    a. Constant-flow domestic hot water circulation systems.

3. Testing, adjusting, and balancing of equipment.
4. Sound tests.
5. Vibration tests.
6. Duct leakage tests verification.
7. HVAC-control system verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

A. TAB Report to include, but not limited to:

1. Qualification Data: submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
2. Strategies and Procedures Plan: submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
3. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
4. Certified TAB reports.
5. Instrument calibration reports, to include the following:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by NEBB:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB.

C. TAB Specialists Qualifications, Certified by TABB:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by TABB.
2. TAB Technician: Employee of the TAB specialist and certified by TABB.

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

E. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.7 FIELD CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.

F. Examine equipment performance data, including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible, and their controls are connected and functioning.

K. Examine operating safety interlocks and controls on HVAC equipment.

L. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete, and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
2. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

E. ALL AIR & REFRIGERANT EQUIPMENT LISTED ON MECHANICAL SCHEDULES SHALL BE TESTED, ADJUSTED AND BALANCED.

F. DOMESTIC HOT WATER CIRCULATION SHALL BE TESTED, ADJUSTED AND BALANCED.

3.4 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Fans and ventilators.
3. Terminal units.
4. Unit heaters.
5. Condensing units.
6. Energy-recovery units.
7. Air-handling units.
8. Heating and ventilating units.
9. Dedicated outdoor-air units.
10. Split-system air conditioners.
11. Variable refrigerant flow systems.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' Record drawings duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
   c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:

   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report artificial loading of filters at the time static pressures are measured.

3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-

heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.

c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
d. Adjust controls so that terminal is calling for minimum airflow.
e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

6. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:

a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.

b. Re-measure and confirm that total airflow is within design.
c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
d. Mark final settings.
e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
f. Verify tracking between supply and return fans.

3.8 PROCEDURES FOR MOTORS

A. Motors ½ HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.9 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

A. Verify proper rotation of fan(s).

B. Measure and record entering- and leaving-air temperatures.

C. Measure and record entering and leaving refrigerant pressures.

D. Measure and record operating data of compressor(s), fan(s), and motors.

3.10 SOUND TESTS

A. After systems are balanced and Substantial Completion, measure and record sound levels at five locations as designated by the Architect.

B. Instrumentation:

1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels and measuring the equivalent continuous sound pressure level (L_{eq}).
3. The sound-testing meter must be capable of using one-third octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
4. The accuracy of the sound-testing meter shall be plus or minus one decibel.

C. Test Procedures:

1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
2. Equipment should be operating at design values.
3. Calibrate the sound-testing meter prior to taking measurements.
4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
5. Record a set of background measurements in dBA and sound pressure levels in the eight unweighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
6. Take sound readings in dBA and sound pressure levels in the eight unweighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
7. Take readings no closer than 36 inchesfrom a wall or from the operating equipment and approximately 60 inchesfrom the floor, with the meter held or mounted on a tripod.
8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:

a. Location.
b. System tested.
c. dBA reading.
d. Sound pressure level in each octave band with equipment on and off.

3.11 DUCT LEAKAGE TESTS

A. Witness the duct leakage testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.12 HVAC CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify that controllers are calibrated and function as intended.
2. Verify that controller set points are as indicated.
3. Verify the operation of valve and damper actuators.
4. Verify that controlled devices are properly installed and connected to correct controller.
5. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
6. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.13 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent or minus 5 percent. If design value is less than 100 cfm, within 10 cfm.
2. Air Outlets and Inlets: Plus 10 percent or minus 5 percent. If design value is less than 100 cfm, within 10 cfm.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.14 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

3.15 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.

3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans performance forms, including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.

f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.
d. Inlet and discharge static pressure in inches wg.
e. For each filter bank, filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
j. Outdoor airflow in cfm.
k. Return airflow in cfm.
l. Outdoor-air damper position.
m. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per incho.c.
f. Make and model number.
g. Face area in sq. ft.
h. Tube size in NPS
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Refrigerant expansion valve and refrigerant types.
i. Refrigerant suction pressure in psig.
j. Refrigerant suction temperature in deg F.

G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft.
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and speed.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave and amount of adjustments in inches.
    g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan speed.
    d. Discharge static pressure in inches wg.
    e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

    a. System fan and air-handling-unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F.
    d. Duct static pressure in inches wg.
    e. Duct size in inches.
    f. Duct area in sq. ft.
    g. Indicated airflow rate in cfm.
    h. Indicated velocity in fpm.
    i. Actual airflow rate in cfm.
    j. Actual average velocity in fpm.
    k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:

    a. System and air-handling unit identification.
    b. Location and zone.
    c. Apparatus used for test.
    d. Area served.
    e. Make.
    f. Number from system diagram.
    g. Type and model number.
    h. Size.
    i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

K. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.16 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.

B. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
6. Outdoor, exposed supply and return.

B. Related Requirements:

1. Section 230719 "HVAC Piping Insulation."
2. Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties, and flanges for each type of insulation.
3. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are to be applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg Fand 220 deg FComply with ASTM C534, Type II for sheet materials.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.

G. Mineral Wool Blanket: Basalt volcanic rock-derived fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg Fin accordance with ASTM C447. Comply with ASTM C553.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Johns Manville.
b. Owens Corning.
c. Rockwool Technical Insulation.

2.3 FIRE RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. CertainTeed Corp.: FlameChek.
b. Johns Manville: Firetemp Wrap.
c. Nelson Firestop Products: Nelson FSB Flameshield Blanket.
d. Thermal Ceramics: FireMaster Duct Wrap.
e. 3M: Fire Barrier Wrap Products
f. Unifrax Corp.: FyreWrap

2.4 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Aeroflex USA, Inc.; Aeroseal.
    b. Armacell LLC; Armaflex 520 Adhesive.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
    d. K-Flex USA; R-373 Contact Adhesive.

C. Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; CP-82.
    b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    c. Mon-Eco Industries, Inc.; 22-25.

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    b. Eagle Bridges - Marathon Industries; 225.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

2.5 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water Based, Interior Use: Suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Exterior Use: Suitable for outdoor use on below ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-76-8.
b. Marathon Industries, Inc.; 405.
c. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

2.7 SECUREMENTS

A. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inchthick by 2 inchessquare.
b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Baseplate: Perforated, nylon sheet, 0.030 inchthick by 1-1/2 inchesin diameter.
    b. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Baseplate: Galvanized carbon-steel sheet, 0.030 inchthick by 2 inchessquare.
    b. Spindle: Copper- or zinc-coated, low-carbon steel fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    c. Adhesive-backed base with a peel-off protective cover.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inchsoft-annealed, stainless steel.

2.8 CORNER ANGLES

A. PVC Corner Angles: 30 milsthick, minimum 1 by 1 inch, PVC in accordance with ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C921, Type I, unless otherwise indicated.

B. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Johns Manville; Zeston.
    b. RPR Products

2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. Sheet and roll stock ready for shop or field sizing.
    b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

3. Stainless-Steel Jacket: ASTM A167 or ASTM A240/A240M.

a. Sheet and roll stock ready for shop or field sizing.
b. Material, finish, and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

C. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

a. MFM building Products Corporation.
b. Polyguard; Alumaguard 60.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

a. 3M Industrial Adhesives.
b. Ideal Tape Co.
c. Knauf Insulation.

2. Width: 3 inches.
3. Thickness: 11.5 mils
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

    a. 3M Industrial Adhesives.
    b. Ideal Tape Co.
    c. Knauf Insulation.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces, free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Cut insulation in a manner to avoid compressing insulation.

L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inchesbeyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inchesbelow top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC AND POLYOLEFIN INSULATION

A. Comply with manufacturer's written installation instructions and ASTM C1710.

B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Square and Rectangular Ducts and Plenums:

1. Provide 1/4 inchmore per side for a tight, compression fit.
2. Cut sheet insulation with the following dimensions:

    a. Width of duct plus 1/4-inch, one piece.
    b. Height of duct plus 1/4 inch, plus thickness of insulation, two pieces.
    c. Width of duct plus 1/4 inch, plus two times the thickness of insulation, one piece.

3. Insulate the bottom of the duct with the sheet from (a) above, then the sides with the two sheets from (b) above, and finally the top of the duct with the sheet from (c) above.
4. Insulation without self-adhering backing:

    a. Apply 100 percent coverage of manufacturer adhesive on the metal surface, then the insulation, except for the last 1/4 inchwhere sheets will butt together.
    b. Roll sheet down into position.
    c. Press two sheets together under compression and apply adhesive at the butt joint to seal the two sheets together.

5. Insulation with self-adhering backing:

    a. Peel back release paper in 6- to 8-inchincrements and line up sheet.
    b. Press firmly to activate adhesive.
    c. Align material and continue to line up correctly, pressing firmly while slowly removing release paper.
    d. Allow 1/4-inchoverlap for compression at butt joints.
    e. Apply adhesive at the butt joint to seal the two sheets together.

6. Insulate duct brackets following manufacturer's written installation instructions.

D. Circular Ducts:

1. Determine the circumference of the duct, using a strip of insulation the same thickness as to be used.
2. Cut the sheet to the required size.
3. Apply 100 percent coverage of manufacturer adhesive on the metal surface then the insulation.
4. Apply manufacturer adhesive to the cut surfaces along 100 percent of the longitudinal seam. Press together the seam at the ends and then the middle. Close the entire seam starting from the middle.

3.6 INSTALLATION OF GLASS-FIBER AND MINERAL-WOOL INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. Comply with manufacturer's written installation instructions.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inchesand smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not over-compress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-incho.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern

over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inchoverlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 incheso.c. and at end joints.

3.8 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Ducts and plenums in accordance with section 3.11 below
2. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
3. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1, and section 3.11 below:
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

DUCT TYPE	DUCT LOCATION	INSULATION R-VALUE	INSULATION TYPE	OTHER REQUIREMENTS
Outside/ Ventilation Air Supply	Outside / Ventilation Air duct downstream of DOAS. Located within conditioned space.	None	None	Applies to conditioned outside ventilation air with supply temp between 55°F and 105°F
Return Air	Located within conditioned space.	None	None	None
Transfer Air	Located within conditioned space	None	Duct liner	Section 233113 "Metal Ducts" for duct liners.
Supply Air	Supply air duct downstream of VRF indoor units. Located within conditioned space.	R-3.3	Mineral fiber blanket or rigid fiber board.	Insulation is not required where ductwork is exposed to view in the space/zone it serves
Supply, Return, Exhaust, Outside Air	All ductwork located outside of the building envelope. Provide with vapor/weather barrier and field applied jacket per specifications and details.	R-12	Rigid fiber board.	Duct liner with equal insulation value may be used with prior review by EOR/Owner.
Exhaust Air	Exhaust air duct downstream of exhaust air backdraft/shut-off damper and upstream of exterior wall/roof duct penetration. Located within conditioned space.	R-7	Mineral fiber blanket or rigid fiber board.	Insulation is not required if backdraft/shut-off damper and wall/roof duct penetration is located within the same assembly.
Type I Commercial Kitchen Hood Exhaust Duct	All	None	Fire rated board or wrap	2-hour fire rating minimum
Type II Vapor Hood Exhaust Duct	All	R-8	Mineral fiber blanket or rigid fiber board.	Insulation shall have maximum operating temperature of 250°F.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches: Aluminum, Smooth: 0.020 inch thick.

D. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches: Painted Aluminum, Smooth 2-1/2-Inch-Deep Corrugations: 0.040 inch thick.

E. Rectangular duct shall have horizontal surfaces sloped to drain using insulation and jacket to provide slope.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulation for HVAC piping systems.

B. Related Requirements:

1. Section 230713 "Duct Insulation" for duct insulation.
2. Section 238129 “Variable Refrigerant Flow HVAC Systems” for additional requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

1.3 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size.

B. Materials on site shall be stored inside, protected from weather conditions, and shall not be subjected to direct, or indirect, moisture. Any insulation which has been subjected to moisture shall be removed from the site and shall not be used and installed.

1.4 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.5 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authority having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg Fand 220 deg F. Comply with ASTM C534/C534M, Type I, for tubular materials.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.

G. **Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.**

1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:**

   a. **Johns Manville; a Berkshire Hathaway company.**
   b. **Owens Corning**.
   c. **ROCKWOOL**.

2. **Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.**
3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Mineral Wool, Preformed Pipe: Mandrel-wound mineral wool fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg F in accordance with ASTM C447. Comply with ASTM C547.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Johns Manville; a Berkshire Hathaway company.
   b. Owens Corning.
   c. ROCKWOOL.

2. Preformed Pipe Insulation: Type II, Grade A with factory applied ASJ.
3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.

I. Mineral Wool, Pipe and Tank: Mineral wool fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1000 deg F, in accordance with ASTM C411. Comply with ASTM C1393.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Johns Manville; a Berkshire Hathaway company.
   b. Owens Corning.
   c. ROCKWOOL.

2. Semirigid board material with factory applied ASJ or ASJ+ jacket.
3. Factory-applied jacket requirements are specified in "Factory Applied Jackets" Article.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor application, use adhesive that has a VOC content of 50g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
4. Wet Flash Point: Below 0 deg F.
5. Service Temperature Range: 40 to 200 deg F.
6. Color: Black.
7. Color: White.

C. Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.

2. For indoor application, use adhesive that has a VOC content of 80g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Adhesive and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.

2. For indoor application, use adhesive that has a VOC content of 50g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 SEALANTS

A. ASJ Flashing Sealants and PVDC and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F
4. For indoor application, use adhesive that has a VOC content of 420g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall be ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; comply with ASTM C1136, Type I, unless otherwise indicated.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. 3M Industrial Adhesives and Tapes Division.
   b. Avery Dennison Corporation, Specialty Tapes Division.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.8 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.
3. Nameplates and data plates.

3.4 PENETRATIONS

A. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using prefabricated fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with prefabricated fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
6. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe, three locations of fittings, for each pipe service defined in the "Piping Insulation Schedule, General" Article.

B. All insulation applications will be considered defective if they do not pass tests and inspections.

C. Perform and provide tests and inspections reports.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Underground piping.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 PIPING INSULATION SCHEDULE

A. Comply with requirements in Section 238129 "Variable Refrigerant Flow HVAC Systems" for system piping insulation requirements for refrigerant and condensate piping.

B. Comply with minimum requirements of ASHRAE 90.1 – 2019 per table below:

PART 4 -

Fluid Operating Temperature Range (°F)	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity (Btu*in/h*ft^2*°F)	Mean Rating Temperature (°F)	< 1	1 to < 1-1/2	1-1/2 to < 4	4 to < 8	≥ 8
			Insulation Thickness (in.)				
> 350	0.32 to 0.34	250	4.5	5.0	5.0	5.0	5.0
251 to 350	0.29 to 0.32	200	3.0	4.0	4.5	4.5	4.5
201 to 250	0.27 to 0.30	150	2.5	2.5	2.5	3.0	3.0
141 to 200	0.25 to 0.29	125	1.5	1.5	2.0	2.0	2.0
105 to 140	0.22 to 0.28	100	1.0	1.0	1.5	1.5	1.5
40 to 105	0.21 to 0.27	75	0.5	0.5	1.0	1.0	1.0
< 40	0.20 to 0.26	50	0.5	1.0	1.0	1.0	1.5

Note: Table above is per ASHRAE 90.1-2019 and is applicable to hot water heating, chilled water, domestic hot and cold water.

4.1 FIELD APPLIED JACKED SCHEDULE

A. Install jacket over insulation material.

B. Indoor – exposed.

1. Where ASJ is not factory applied to insulation, provide field applied ASJ.

C. Indoor – concealed.

1. None.

END OF SECTION 230719

SECTION 230800 – COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Owner's Project Requirements and Basis-of-Design Document are included by reference for information only.

1.2 ASHRAE Guideline 0 and 1.

A. Project’s Commissioning Plan: The commissioning plan is prepared by CxA and expands and makes more specific the information contained here.

1.3 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. The Commissioning (Cx) process requires the active involvement of the responsible builder (General Contractor or Construction Manager) and the affected Division contractors (Subs) and assigns work and responsibilities that are specified here. (For this specification "Construction Manager" or "CM" will be used to refer to the responsible builder.)

1.4 COMMISSIONING

A. Section includes Cx process requirements for the following HVAC systems, assemblies, and equipment:

1. Heat generation systems
2. Cooling generation systems
3. Central-station air-handling systems
4. Air, steam, and hydronic distribution systems
5. Heating and cooling terminal and unitary equipment
6. HVAC controls
7. Unit Heaters
8. Exhaust and Ventilation Fans (kitchen, storage, laundry, toilet, misc. spaces)
9. Kitchen Refrigeration System
10. Kitchen Hoods
11. Kitchen Supply Air System
12. Kitchen Gas Connections

13. Electric Heating (Cabinet and Unit Heaters)
14. Refrigeration System
15. Piping
16. TAB verification

B. Additional details of systems required to be commissioned:

1. Cooling generation systems, including the following:

    a. Direct-expansion refrigeration systems.

2. Air-handling systems, including the following:

    a. Supply, return, and exhaust air fans, motors, and drives.
    b. Automatic and gravity dampers.
    c. Heating and cooling devices.
    d. Humidification and dehumidification devices.
    e. Air filters.
    f. Hangers and supports.
    g. Interlock between air-handling system and fire/smoke alarm system.

3. Air duct systems, including the following:

    a. Duct systems.
    b. Air-duct accessories, including volume dampers, fire and smoke dampers, turning vanes, sound attenuators, and flexible connectors.
    c. Duct-mounted access doors and panels.
    d. Hangers and supports.
    e. Sound Attenuation

4. Hydronic distribution systems, including the following:

    a. Hydronic piping systems and all accessories.
    b. Pumps and all accessories.
    c. Sleeves and sleeve seals.
    d. Meters and gauges.
    e. General-duty and specialty valves.
    f. Hangers and supports.

5. Refrigerant piping, including the following:

    a. Refrigerant piping, fittings, and specialties.
    b. Refrigerant charge.
    c. Sleeves and sleeve seals.
    d. Meters and gauges.
    e. General-duty and specialty valves.
    f. Hangers and supports.

6. Cooling terminal and unitary equipment, including the following:

a. Unit ventilators.
b. Fan-coil units.
c. Unitary cooling equipment.
d. Heat Pipes

7. Vibration isolation systems.
8. Controls and instrumentation, including the following:

a. Energy monitoring and recording system.
b. Controllers and sensors.
c. Automatic control valves, dampers, and actuators.
d. Control interface with fans, pumps, dampers, and other equipment and systems.
e. Demand-control systems.

9. TAB Verification:

a. Airflow.
b. Water flow.
c. Space pressurization.

10. Documentation:

a. Mechanical systems manuals.
b. Documentation of required commissioning.

11. Mechanical insulation, including the following:

a. Duct and plenum insulation.
b. HVAC piping insulation.

C. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For construction checklists, comply with requirements in various Division 23 Sections specifying HVAC systems, system components, equipment, and products and ASHRAE Guideline 1.1-2007 “HVAC&R Technical Requirements for the Commissioning Process”, AHSRAE Guideline 0-2013 “The Commissioning Process.”

D. Definitions

1. Retain terms that remain after this Section has been edited for a project.
2. BAS: Building automation system.
3. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."
4. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."
5. IgCC: International Green Construction Code.

6. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they mean "as-built" systems, assemblies, subsystems, equipment, and components.
7. TAB: Testing, adjusting, and balancing.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For BAS and HVAC testing technician.

1.6 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians performing BAS Cx test demonstrations are to have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of BAS, HVAC, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. International Society of Automation (ISA)-Certified Control Systems Technician (CCST) Level I.

B. HVAC Testing Technician Qualifications: Technicians to perform HVAC Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level; vocational school four-year-program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC equipment, assemblies, and systems.
2. Minimum three years' experience that is to include installing, servicing, and operating systems manufactured by approved manufacturer.

C. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.

3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 Cx PROCESS:

A. Perform Cx process in accordance with Section ASHRAE Commissioning Requirements" for BAS, HVAV, Plumbing, Building Components, and Solar Energy Systems in accordance with the following:

1. ASHRAE Guideline 1.1-2007 “HVAC&R Technical Requirements for the Commissioning Process”, AHSRAE Guideline 0-2013 “The Commissioning Process” and ASHRAE 202.

3.2 Cx TESTING PREPARATION

A. Certify that HVAC systems, subsystems, and equipment have been Designed according the owners requirement and commissioning plan (Formal review at design development, 50% construction documents, and Permit Documents), installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that HVAC instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and all systems are set to and maintaining set points as required by the design documents.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.3 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Owner, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated

conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.

2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

B. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.

C. Seasonal test complete appropriate initial performance tests and documentation, and schedule seasonal tests.

3.4 Cx TESTS COMMON FOR ALL COMMISSIONED SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response in accordance with acceptance criteria.

C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 23 Sections specifying HVAC systems and equipment.

E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

1. Cx Construction Checklist verification tests.

F. Verify integration into the local BAS system and the System Wide Enterprise system.

3.5 TAB VERIFICATION

A. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

B. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

C. Scope: HVAC air systems and hydronic piping systems.

D. Purpose: Differential flow relationships intended to maintain air and water pressurization differentials between the various areas of Project.

E. Conditions of the Test:

1. Cx Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Systems operating in full cooling mode.
3. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

F. Acceptance Criteria:

1. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than the tolerances allowed.
3. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

END OF SECTION 230800

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units. All electrical wiring, raceways, breakers, transformers, final connections, and other miscellaneous equipment necessary to provide power to the Controls shall be provided as part of the Control system unless explicitly indicated in work of other Divisions. Convenience outlets and convenience outlet circuits shall not be used as a source of power.

B. Architecture: Resident BACnet IP.

C. Related Sections:

1. Section 220519 “Meters and Gages for Plumbing Piping”.
2. Section 220800 “Commissioning of Plumbing”.
3. Section 221119 “Domestic Water Piping Specialties".
4. Section 230800 “Commissioning of HVAC”.
5. Section 233423 “HVAC Power Ventilators”.
6. Section 233600 "Air Terminal Units".
7. Section 238126 “Split-System Air-Conditioners”.
8. Section 238129 “Variable- Refrigerant-Flow HVAC Systems”.
9. Section 238216.14 “Electric-Resistance Air Coils”.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. MS/TP: Master slave/token passing.

D. PC: Personal computer.

E. PID: Proportional plus integral plus derivative.

F. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

    a. Water Temperature: Plus or minus 1 deg F.
    b. Water Flow: Plus or minus 5 percent of full scale.
    c. Water Pressure: Plus or minus 2 percent of full scale.
    d. Space Temperature: Plus or minus 1 deg F.
    e. Ducted Air Temperature: Plus or minus 1 deg F.
    f. Outside Air Temperature: Plus or minus 2 deg F.
    g. Temperature Differential: Plus or minus 0.25 deg F.
    h. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
    i. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
    j. Airflow (Terminal): Plus or minus 10 percent of full scale.
    k. Air Pressure (Space): Plus or minus 0.01-inch wg.
    l. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
    m. Carbon Dioxide: Plus or minus 50 ppm.

1.5 SEQUENCE OF OPERATION

A. As indicated.

1.6 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface

equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:

    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:

    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

C. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

D. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

E. Qualification Data: For Installer and manufacturer.

F. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer. In the event equipment manufacturer cannot, or will not, factory mount controls, controls shall be field mounted.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 26 Section "Digital-Network Lighting Controls” to achieve compatibility with equipment that interfaces with that system.

C. Coordinate equipment with fire alarm contractor to achieve compatibility with equipment that interfaces with fire alarm system.

D. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor controller thermostat positioning relay.
2. Maintenance Materials: Two thermostat adjusting keys.

1.11 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
c. As-built versions of submittal Product Data.
d. Names, addresses, email addresses, and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to do the following:
h. Design and install new points, panels, and other hardware.

1) Perform preventive maintenance and calibration.
2) Debug hardware problems.
3) Repair or replace hardware.

i. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
j. Backup copy of graphic files, programs, and databases on electronic media.
k. List of recommended spare parts with part numbers and suppliers.
l. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
m. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
n. Licenses, guarantees, and warranty documents.

o. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
p. Owner training materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, furnish products and systems installed by the following

a. Automated Logic Corp. products and systems, furnished and installed by Authorized Dealer

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

C. The control system shall be fully functional and interface to Automated Logic WebCTRL System 6.0 or newer and provided with a graphical user interface. The control system shall be accessible via the internet. The control system shall be accessible via a computer located in the YAWN building security operations center / central command in a data center on site, connected over the corp net with an air gap or other solution.

2.2 DDC EQUIPMENT

A. User Interface with controls shall have the minimum configuration as follows:

1. Application Software:

a. I/O capability from operator station.
b. System security for each operator via software password and access levels.
c. Automatic system diagnostics; monitor system and report failures.
d. Database creation and support.
e. Automatic and manual database save and restore.
f. Dynamic color graphic displays with up to 10 screen displays at once.
g. Custom graphics generation and graphics library of HVAC equipment and symbols.
h. Alarm processing, messages, and reactions.
i. Trend logs retrievable in spreadsheets and database programs.

j. Alarm and event processing.
k. Object and property status and control.
l. Automatic restart of field equipment on restoration of power.
m. Data collection, reports, and logs. Include standard reports for the following:

1) Current values of all objects.
2) Current alarm summary.
3) Disabled objects.
4) Alarm lockout objects.
5) Logs.

n. Custom report development.
o. Utility and weather reports.
p. Workstation application editors for controllers and schedules.
q. Maintenance management.

2. Custom Application Software:

a. English language oriented.
b. Full-screen character editor/programming environment.
c. Allow development of independently executing program modules with debugging/simulation capability.
d. Support conditional statements.
e. Support floating-point arithmetic with mathematic functions.
f. Contains predefined time variables.

B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.
d. Software applications, scheduling, and alarm processing.
e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, anti-short cycling, PID control, DDC with fine tuning, and trend logging.
b. HVAC Control Programs: Optimal run time, supply-air reset.

c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
d. Remote communications.
e. Maintenance management.
f. Units of Measure: Inch-pound.

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or

D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations and controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.3 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics, monitor system and report failures.
3. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

2.4 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.

1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
2. Proportional band shall extend from 2 to 20 percent for 5 psig.
3. Authority shall be 20 to 200 percent.
4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal of zero to supply pressure.
5. Gages: 2-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.5 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Accuracy: Plus or minus 0.36 deg F at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
4. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
    a. Set-Point Adjustment: Concealed.
    b. Set-Point Indication: Exposed.
    c. Thermometer: Exposed.
    d. Color: Black.
    e. Orientation: Vertical.
    f. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
7. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:

1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
4. Averaging Elements in Ducts: 18 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
7. Set-Point Adjustment: Concealed.

a. Set-Point Indication: Exposed.
b. Thermometer: Concealed.
c. Color: Black.
d. Orientation: Vertical.

8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Pressure Transmitters/Transducers:

1. Available Manufacturers:

a. BEC Controls Corporation.
b. General Eastern Instruments.
c. MAMAC Systems, Inc.
d. ROTRONIC Instrument Corp.
e. TCS/Basys Controls.
f. Vaisala.

2. Static-Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.

a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
b. Output: 4 to 20 mA.
c. Building Static-Pressure Range: 0- to 0.25-inch wg.
d. Duct Static-Pressure Range: 0- to 5-inch wg.

3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

E. Room Sensor Cover Construction: Manufacturer's standard locking covers.

1. Set-Point Adjustment: Concealed.
2. Set-Point Indication: Exposed.
3. Thermometer: Concealed.
4. Color: Black.
5. Orientation: Vertical.

F. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
3. Adjusting Key: As required for calibration and cover screws.

2.6 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

C. Power Monitoring Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for intended application.

    a. Type: Split and solid core.

D. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

E. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

2.7 FLOW MEASURING STATIONS

A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.

1. Available Manufacturers:
2. Air Monitor Corporation.

    a. Wetmaster Co., Ltd.

3. Casing: Galvanized-steel frame.
4. Flow Straightener: Aluminum honeycomb, 3/4-inch parallel cell, 3 inches deep.
5. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

B. Fan Inlet Airflow Station: Face mounted multiple sensors.

1. Available Manufacturer:

    a. Ebtron.

2. Sensor Assembly: Hermetically sealed bead in glass heated element thermistor, glass filled polypropylene sensor housing, marine grade waterproof epoxy potting material.
3. Output: Analog.
4. Accuracy:
5. Cable Assembly: Plenum rated, PVC jacket.
6. Transmitter: BACnet.

2.8 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Available Manufacturers:

    a. Belimo Aircontrols (USA), Inc.

2. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Non-spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
6. Non-spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf
7. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Available Manufacturers:

    a. Belimo Aircontrols (USA), Inc.

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:

    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.

9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 deg F.
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
12. Run Time: 12 seconds open, 5 seconds closed.

2.9 CONTROL VALVES

A. Control Valves: Factory fabricated, globe type; body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

2.10 ELECTROMAGNETIC FLOWMETERS

A. Insertion Electromagnetic Flow Meters

1. Description: Insertion Turbine Flow Meter complete with all installation hardware necessary (branch outlet, close nipple, and full-port ball valve) to enable insertion and removal of the flow meter without system shutdown.
2. Accuracy: ±1.0% of reading from 2–20 ft/sec and ±0.02 ft/sec below 2 ft/sec
3. Construction: The flow sensor shall be constructed of plated brass (or 316 stainless steel as required by the application), with standard features to include a weather-tight electronics enclosure and half inch conduit connection fitting. The turbine elements shall be made of polypropylene or polysulfone with sapphire jewel bearings and tungsten carbide shafts.
4. Ratings:

    a. Pressure: 400 psig.
    b. Temperature: 250 F.

5. Output Signals Provided: 4–20mA, 0–10V or 0–5V, scalable pulse output.
6. Display: Optional remote visual instantaneous rate of flow and totalized flow.
7. A certificate of calibration shall be provided with each flow meter.
8. Manufacturer:

    a. ONICON F-3500 Series
    b. Or approved equal.

2.11 DAMPERS

A. Dampers: AMCA-rated, opposed-blade design; 0.108-inch minimum thick, galvanized-steel or 0.125-inch minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed

against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.

2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf, when tested according to AMCA 500D.

2.12 RACEWAYS, BOXES, AND CABINETS

A. Raceways, Boxes, and Cabinets: In accordance Division 26 Section "Raceway and Boxes for Electrical Systems."

2.13 BUI`LDING WIRE AND CABLE

A. Building Wire and Cable: In accordance Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

3.2 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, and other exposed control sensors with Drawings and room details before installation. Install devices 60 inches above the floor.

D. Install guards on thermostats in the following locations:

1. Entrances.
2. Public areas.
3. Where indicated.

E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Install transient voltage and surge-suppressors.

H. Install power monitoring sensors.

I. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

J. Furnish unit controls to Division 23 Section “Air Terminal Units” manufacturer for factory mounting.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable:

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

2. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
3. Test each point through its full operating range to verify that safety and operating control set points are as required.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.
6. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
5. Check temperature instruments and material and length of sensing elements.
6. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
7. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature set points.

C. Occupancy Adjustments: When requested within 12 months of date of First Day of Business (FDOB), provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 230900

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Valves and specialties.
4. Refrigerants.

B. Related Requirements:

1. Section 238129 “Variable Refrigerant Flow HVAC Systems” for additional requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Pressure-regulating valves.

B. Product Data Submittals: For each product.

1. Submit data for each type of refrigerant piping, fitting, valve, piping specialty, and refrigerant.

C. Delegated Design Submittals: For refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

D. Shop Drawings:

1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: 1/8-inch equals 1 foot.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

B. Prepare valves and specialties for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads and other end connections.

C. Use the following precautions during storage:

1. Maintain valve and specialty end protection.
2. Store valves and specialties indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," for refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

B. Comply with ASHRAE 15.

C. Comply with ASME B31.5.

D. Pressure Testing for Refrigerant Piping: Follow manufacturer’s installation, service, and repair instructions for pressure testing and leak detection of all refrigerant piping. Use suitable test pressures for specific installation application. Piping must hold pressure for a minimum of 1 hour.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B280, Type ACR.

B. Wrought-Copper Fittings, Solder Joint: ASME B16.22.

C. Wrought-Copper Fittings, Brazed Joint: ASME B16.50.

D. Wrought-Copper Unions: ASME B16.22.

E. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

F. Brazing Filler Metals: AWS A5.8M/A5.8.

G. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inchmisalignment in minimum 7-inch-long assembly.
4. Working Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Service Valves:

1. Body: Forged brass with brass cap, including key end to remove core.
2. Core: Removable ball-type check valve with stainless steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

B. Refrigerant Locking Caps:

1. Description: Locking-type, tamper-resistant, threaded caps to protect refrigerant-charging ports from unauthorized refrigerant access and leakage.
2. Material: Brass, with protective shroud or sleeve.
3. Refrigerant Identification: Universal design.
4. Special Tool: For installing and unlocking.

C. Solenoid Valves: Comply with AHRI 760 I-Pand UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inchconduit adapter, and 24 V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.

D. Thermostatic Expansion Valves: Comply with AHRI 750 I-P.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 450 psig.

2.4 REFRIGERANTS

1. **R-32 (Difluoromethane), A2L Class**
2. R-454B (Blend of R-32 and R1234yf), A2L Class

PART 3 - EXECUTION

3.1 PIPING APPLICATION SCHEDULES

A. Refrigerant: **R-32, R454B**

B. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, Copper: Type ACR tubing and wrought-copper fittings with brazed joints.

D. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

E. Safety-Relief-Valve Discharge Tubing for Heat-Pump Applications, Copper: Type ACR tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

C. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

D. Install flexible connectors at compressors.

E. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to authority having jurisdiction.

3.3 INSTALLATION OF PIPING, GENERAL

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping in accordance with ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 230900 "Instrumentation and Control for HVAC” and M5.# sheets for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves in accordance with Section 230553 "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Construct joints in accordance with ASTM B828, flux conforming to ASTM B813, solder conforming to ASTM B32 and CDA's "Copper Tube Handbook."

1. Soldered joints shall be limited to Group A1 refrigerants in applications with less than or equal to 200 psi where permitted by local jurisdiction.

D. Brazed Joints: Construct joints in accordance with AWS BRH, "Brazing Handbook," Ch. 35, "Pipe and Tubing."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

E. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 ft.long.
2. Roller hangers and spring hangers for individual horizontal runs 20 ft.or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 ft.or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inchesof each fitting.

E. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System must maintain test pressure at the manifold gauge throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.

d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

C. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions.

E.

F. END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. **Double-wall round ducts and fittings**
4. Sheet metal materials.
5. Duct liner.
6. Sealants and gaskets.
7. Hangers and supports.

B. Related Requirements:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Dimensions of all duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

12. Hangers and supports, including methods for duct and building attachment, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", ASCE/SEI 7, SMACNA's "Round Industrial Duct Construction Standards."

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

E. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inchesor greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Source Limitations: Obtain single-wall round ducts and fittings from single manufacturer.

C. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for

static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inchesin diameter with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 DOUBLE-WALL ROUND DUCTS AND FITTINGS

A. **Source Limitations: Obtain double-wall round ducts and fittings from single manufacturer.**

B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. **Construct ducts of galvanized sheet steel unless otherwise indicated.**

C. **Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."**

1.
2. Transverse Joints in Ducts Larger Than **60Inches**in Diameter: Flanged.

D. **Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."**

E. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Inner Duct: Minimum **24-gauge**solid galvanized sheet steel.

G. Interstitial Insulation, Fibrous Glass: Duct liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. **Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg Fat 75 deg F mean temperature.**
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

H. **Interstitial Insulation, Flexible Elastomeric: Duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.**

1. **Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg Fat 75 deg Fmean temperature.**

2.5 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish is to be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.

D. Aluminum Sheets: Comply with ASTM B209Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

E. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, 1/4-inch-minimum diameter for lengths 36 inchesor less; 3/8-inch-minimum diameter for lengths longer than 36 inches.

2.6 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Basis of Design: Ductmate Polyarmor Polyester Duct liner.
2. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested in accordance with ASTM C518.
3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with ASTM E84; certified by an NRTL.
4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inchgalvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inchesin diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Secure liner with mechanical fasteners 4 inchesfrom corners and at intervals not exceeding 12 inchestransversely; at 3 inchesfrom transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.

8. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.7 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.

2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal is to provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wgand is to be rated for10-inch wgstatic-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.8 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

D. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.

E. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations.

Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.

L. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inchesand smaller and a minimum of five segments for 14 inchesand larger.

M. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCTWORK EXPOSED TO WEATHER

A. All external joints are to be welded. Seal all openings to provide weatherproof construction.

B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.

C. Single Wall:

1. Ductwork is to be Type 304 stainless steel.
2. Ductwork is to be galvanized steel.
3. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 230713 "Duct Insulation."

3.4 DUCT SEALING

A. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wgand Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wgand Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inchesthick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inchesthick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inchesof each elbow and within 48 inchesof each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 DUCTWORK CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. Supply Ducts with a Pressure Class of 2-Inch wgor Higher: Test representative duct sections, totaling no less than 50 of total installed duct area for each designated pressure class.
    b. Return Ducts with a Pressure Class of 2-Inch wgor Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
    c. Exhaust Ducts with a Pressure Class of 2-Inch wgor Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
    d. Outdoor-Air Ducts with a Pressure Class of 2-Inch wgor Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
7. Give seven days' advance notice for testing.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive 1-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 8.

2. Ducts Connected to Constant-Volume Air-Handling Units:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 8.

3. Ducts Connected to Variable-Air-Volume Air-Handling Units:

a. Pressure Class: Positive 4-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 8.

4. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 8.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 8.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 8.

3. Ducts Connected to Equipment Not Listed above:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 8.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

    a. Pressure Class: Negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 8.
    d. SMACNA Leakage Class for Round and Flat Oval: 8.

2. Ducts Connected to Air-Handling Units:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 8.
    d. SMACNA Leakage Class for Round and Flat Oval: 8.

3. Ducts Connected to Type I Hoods: Comply with NFPA 96

    a. Constructed per below or listed grease ducts installed in accordance with the terms of the listing and manufacturer’s instructions.
    b. Materials:

        1) Stainless-steel not less than 0.048 inches (No. 18 MSG) in thickness.

    c. Installation: Liquid tight welded seams, joints, and penetrations. Butt welded connections shall not be permitted.
    d. Pressure Class: Positive or negative 3-inch wg.
    e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations per above.
    f. SMACNA Leakage Class: 3
    g. Do not install turning vanes in ductwork.

4. Ducts Connected to Type II Hoods:

    a. Materials: Stainless-steel not less than 0.048 inches (No. 18 MSG) in thickness.
    b. Pressure Class: Positive or negative 3-inch wg.
    c. Minimum SMACNA Seal Class: A.
    d. SMACNA Leakage Class: 3.
    e. Do not install turning vanes in ductwork.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Stainless Steel Ducts:

    a. Exposed to Airstream: Match duct material.
    b. Not Exposed to Airstream: Galvanized.

3. Aluminum Ducts: Aluminum.

F. Liner:

1. Supply-Air Ducts: Fibrous glass, Type I, 1inchthick.

a. Install liner where specified per drawings downstream of VAV units.

2. Transfer-Air Ducts: Fibrous glass, Type I, 1inchthick.

a. Install in all transfer air ductwork.

G. **Double-Wall Duct Interstitial Insulation:**

1. **Supply-Air Ducts: 1-1/2inchthick.**

H. Elbow Configuration:

1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpmor Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
2) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpmor Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct - Requirements for All Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1,

"Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpmor Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpmor Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12Inchesand Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14Inchesand Larger in Diameter: Standing seam.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Conical spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpmor Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpmor Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Control dampers.
3. Flange connectors.
4. Duct silencers.
5. Turning vanes.
6. Remote damper operators.
7. Duct-mounted access doors.
8. Duct access panel assemblies.
9. Flexible connectors.
10. Duct accessory hardware.

B. Related Requirements:

1. Section 233346 "Flexible Ducts" for insulated and non-insulated flexible ducts.
2. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances, and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.

d. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 BACKDRAFT DAMPERS

A. Description: Gravity balanced.

B. Performance:

1. Maximum Air Velocity: **1000 fpm**
2. Maximum System Pressure: **2 inches wg**
3. Leakage:

a. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.

C. Construction:

1. Frame:

a. Hat shaped.
b. 0.08-inch-thick extruded aluminum, with welded or mechanically attached corners.

2. Blades:

a. Multiple single-piece blades.
b. Pivoted, maximum 6-inch width, **16-gauge-** thick, noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges.

3. Blade Action: Parallel.

D. Blade Seals: Replaceable neoprene, mechanically locked.

E. Blade Axles:

1. Material: Galvanized steel.
2. Diameter: **0.20 inch**.

F. Tie Bars and Brackets: **Galvanized steel**.

G. Return Spring: Adjustable tension.

H. Bearings: Brass sleeve or synthetic pivot bushings.

I. Damper Actuator – Electric or Gravity:

1. Provide electric actuator or gravity actuator where noted in plans
2. Electric - **24 V ac**.
3. UL 873 plenum rated.
4. Two position with fail-safe spring return.

a. Sufficient motor torque **and spring torque** to drive damper fully closed/open with adequate force to achieve required damper seal.
b. Minimum 90-degree drive rotation.

5. Clockwise or counterclockwise drive rotation as required for application.
6. Environmental Operating Range:

a. Temperature: Minus 40 to plus 130 deg F.
b. Humidity: 5 to 95 percent relative humidity noncondensing.

7. Environmental Enclosure: NEMA 2.
8. Actuator to be factory mounted and provided with a single-point wiring connection.

J. Controllers, Electrical Devices, and Wiring:

1. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Electrical Connection: 24 V, 60 Hz.

K. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Chain pulls.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Performance:

    a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft.against 1-inch wgdifferential static pressure.

2. Construction:

    a. Linkage out of airstream.
    b. Suitable for horizontal or vertical airflow applications.

3. Frames:

    a. Hat-shaped, 18-gauge-thick stainless steel.
    b. Mitered and welded corners.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized steel; 16 gaugethick.

5. Blade Axles: Galvanized steel.
6. Bearings:

    a. Oil-impregnated bronze.
    b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

7. Tie Bars and Brackets: Galvanized steel.
8. Locking device to hold damper blades in a fixed position without vibration.

B. Standard, Aluminum, Manual Volume Dampers:

1. Performance:

    a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft.against 1-inch wgdifferential static pressure.

2. Construction:

    a. Linkage out of airstream.
    b. Suitable for horizontal or vertical airflow applications.

3. Frames:

a. Hat-shaped, 0.10-inch-thick, aluminum sheet channels.
b. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
e. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.

5. Blade Axles: Stainless steel.
6. Bearings:

a. Molded synthetic.
b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

7. Tie Bars and Brackets: Aluminum.
8. Locking device to hold damper blades in a fixed position without vibration.

C. Low-Leakage, Steel, Manual Volume Dampers:

1. Performance:

a. AMCA Certification: Test and rate in accordance with AMCA 511.
b. Leakage:

1) Class I: Leakage shall not exceed 4 cfm/sq. ft.against 1-inch wgdifferential static pressure.

2. Construction:

a. Linkage: Out of airstream.
b. Suitable for horizontal or vertical airflow applications.

3. Frames:

a. Hat, U, or angle shaped.
b. Thickness: 16-gaugegalvanized sheet steel.
c. Mitered and welded corners.
d. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized, roll-formed steel; 16 gaugethick.

5. Blade Edging Seals:

    a. Inflatable seal blade edging or replaceable rubber seals.

6. Blade Jamb Seals: Felt.
7. Blade Axles: Galvanized steel.
8. Bearings:

    a. Oil-impregnated bronze.
    b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

9. Tie Bars and Brackets: Galvanized steel.
10. Locking device to hold damper blades in a fixed position without vibration.

D. Low-Leakage, Aluminum, Manual Volume Dampers:

1. Performance:

    a. AMCA Certification: Test and rate in accordance with AMCA 511.
    b. Leakage:

        1) Class I: Leakage shall not exceed 4 cfm/sq. ft.against 1-inch wgdifferential static pressure.

2. Construction:

    a. Linkage out of airstream.
    b. Suitable for horizontal or vertical airflow applications.

3. Frames:

    a. Hat, U, or angle shaped.
    b. Thickness: 0.08-inchaluminum sheet channels.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.

5. Blade Edging Seals:

    a. Inflatable seal blade edging or replaceable rubber seals.

6. Blade Jamb Seals: Felt.
7. Blade Axles: Galvanized steel.
8. Bearings:

a. Oil-impregnated bronze.
b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.

9. Tie Bars and Brackets: Galvanized steel.
10. Locking device to hold damper blades in a fixed position without vibration.

E. Jackshaft:

1. Size: 0.5-inchdiameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle, made of 3/32-inch-thick zinc-plated steel, and a 3/4-inchhexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 CONTROL DAMPERS

A. General Requirements:

1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

B. Performance:

1. AMCA Certification: Test and rate in accordance with AMCA 511.
2. Leakage:

a. Class I: Leakage shall not exceed 4 cfm/sq. ft.against 1-inch wgdifferential static pressure.
b. Class II: Leakage shall not exceed 10 cfm/sq. ft.against 1-inch wgdifferential static pressure.

3. Pressure Drop: 0.05-inch wgat 1500 fpmacross a 24-by-24-inchdamper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Velocity: Up to 3000 fpm
5. Temperature: Minus 25 to plus 180 deg F.
6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

C. Construction:

1. Linkage out of airstream.
2. Suitable for horizontal or vertical airflow applications.
3. Frames:

    a. Hat, U, or angle shaped.
    b. 0.08-inch-thick extruded aluminum.
    c. Mitered and welded corners.
    d. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

    a. Multiple blade with maximum blade width of 6 inches.
    b. Opposed-blade design.
    c. Galvanized steel.
    d. 16-gauge-thick single skin.

5. Blade Edging Seals:

    a. Replaceable Closed-cell neoprene.

6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inchdiameter; galvanized steel.
8. Blade-Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.
9. Bearings:

    a. Oil-impregnated bronze.
    b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.

D. Damper Actuator – Electric

1. Electric - 24 V ac.
2. UL 873, plenum rated.
3. Fully modulating.

    a. Sufficient motor torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
    b. Minimum 90-degree drive rotation.

4. Clockwise or counterclockwise drive rotation as required for application.
5. Environmental Operating Range:

    a. Temperature: Minus 40 to plus 130 deg F
    b. Humidity: 5 to 95 percent relative humidity noncondensing.

6. Environmental enclosure: NEMA 2.
7. Actuator to be factory mounted and provided with a single-point wiring connection.

E. Controllers, Electrical Devices, and Wiring:

1. Comply with requirements for electrical devices and connections specified in Section 230900 "Instrumentation and Control for HVAC."
2. Electrical Connection: 24 V, 60 Hz.

2.5 FLANGE CONNECTORS

A. Description: Add-on, factory fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gauge and Shape: Match connecting ductwork.

2.6 DUCT SILENCERS

A. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
4. Bearing AMCA's Certified Ratings Seal for prefabricated silencer sound and air performance.

B. Shape:

1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.
3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

C. Rectangular Silencer Outer Casing: ASTM A653/A653M, G90galvanized sheet steel, 0.034 inchthick.

D. Inner Casing and Baffles: ASTM A653/A653M, G90galvanized sheet metal, 22 gaugethick, and with 1/8-inch-diameter perforations.

E. Special Construction:

1. Suitable for outdoor use.

F. Connection Sizes: Match connecting ductwork unless otherwise indicated.

G. Principal Sound-Absorbing Mechanism:

1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
2. Dissipative type with fill material.

a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.
b. Erosion Barrier: Polymer bag enclosing fill, heat-sealed before assembly.

3. Lining: None.

H. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Joints: Lock formed and sealed.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

I. Source Quality Control:

1. Test in accordance with ASTM E477.
2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000 fpmface velocity.
3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wgstatic pressure, whichever is greater.

2.7 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

D. Vane Construction:

1. Single wall.

2.8 REMOTE DAMPER OPERATORS

A. Description: Cable system designed for remote manual damper adjustment.

B. Tubing: Brass.

C. Cable: Steel.

D. Wall/Ceiling-Box Mounting: Recessed.

E. Wall/Ceiling-Box Cover-Plate Material: Steel. Painted to match wall/ceiling.

2.9 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."

1. Door:

   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. 24-gauge-thick galvanized steel door panel.
   d. Vision panel.
   e. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
   f. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

   a. 24-gauge-thick galvanized steel or 0.032-inch-thick aluminum frame.

3. Number of Hinges and Locks:

   a. Access Doors Less Than 12 InchesSquare: No hinges and two sash locks.
   b. Access Doors up to 18 InchesSquare: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

2.10 DUCT ACCESS PANEL ASSEMBLIES

A. Access panels used in cooking applications:

1. Labeled compliant to NFPA 96 for grease duct access doors.
2. Labeled in accordance with UL 1978 by an NRTL.

B. Panel and Frame: Minimum thickness 16-gaugecarbon steel.

C. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

D. Gasket: Comply with NFPA 96, grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

E. Minimum Pressure Rating: 10 inches wgpositive or negative.

2.11 FLEXIBLE CONNECTORS

A. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Materials: Flame-retardant or noncombustible fabrics.

D. Coatings and Adhesives: Comply with UL 181, Class 1.

E. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 incheswide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

F. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inchin the warp and 360 lbf/inchin the filling.
3. Service Temperature: Minus 40 to plus 200 deg F

G. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inchin the warp and 440 lbf/inchin the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

2.12 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.13 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and No.2 finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inchminimum diameter for lengths 36 inches or less; 3/8-inchminimum diameter for lengths longer than 36 inches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.

E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

F. Set dampers to fully open position before testing, adjusting, and balancing.

G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

H. Connect ducts to duct silencers rigidly.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. Upstream or downstream from duct silencers.
8. Control devices requiring inspection.
9. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5 inches wgand more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that size and location of access doors are adequate to perform required operation.
3. Inspect turning vanes for proper and secure installation and verify that vanes do not move or rattle.
4. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233346 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Insulated flexible ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For flexible ducts.

1. Include plans showing locations and mounting and attachment details.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."

D. Comply with ASTM E96/E96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Flexmaster USA.
2. McGill Airflow LLC.
3. Thermaflex.

B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: 4-inch wgpositive and 0.5-inch wgnegative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1.

2.3 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

C. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

D. Connect diffusers or light troffer boots to ducts with maximum 60-inchlengths of flexible duct clamped or strapped in place.

E. Connect flexible ducts to metal ducts with liquid adhesive plus tape.

F. Installation:

1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.

G. Supporting Flexible Ducts:

1. Suspend flexible ducts with bands 1-1/2 incheswide or wider and spaced a maximum of 48 inchesapart. Maximum centerline sag between supports shall not exceed 1/2 inchper 12 inches.

2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION 233346

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ceiling-mounted ventilators.
2. In-Line Centrifugal Fans.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Prefabricated roof curbs.
9. Fan speed controllers.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittal: For unit hangers and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. Delegated Design: Engage a qualified professional engineer to design vibration isolators, and supports.

D. Capacities and Characteristics:

1. As indicated on drawings.

2.2 CEILING-MOUNTED VENTILATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Greenheck
2. Loren Cook.

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.

D. Back-draft damper: Integral.

E. Grille: Plastic, louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:

1. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
2. Filter: Washable aluminum to fit between fan and grille.
3. Isolation: Rubber-in-shear vibration isolators.
4. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.3 IN-LINE CENTRIFUGAL FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Greenheck
2. Loren Cook.
3. Approved Alternate.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
3. Companion Flanges: For inlet and outlet duct connections.
4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

G. Capacities and Characteristics: See schedules.

2.4 CENTRIFUGAL UPBLAST ROOF VENTILATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Greenheck.
2. Loren Cook.

3. Approved Alternate

B. Housing: Removable, heavy-gage aluminum, mushroom-domed motor cover and shroud; one-piece, heavy-gage aluminum windband welded to base; aluminum base with prepunched mounting holes and venturi inlet cone. Provide with rain and snow drains and grease collector.

1. Hinged Base: Hinged arrangement permitting service and maintenance.
2. Exterior Coating: Baked enamel decorative coating selected by Architect.

C. Fan Wheels: Non-stick Aluminum hub and wheel with backward-inclined blades.

D. Motors (Direct Drive, 2 HP or Less):

1. Electronic commutation (EC) motor specifically designed for fan applications. Permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal. Motor shall be a minimum of 85% efficient at all speeds.

E. Accessories:

1. Curb Seal.
2. Grease Trap.
3. Vented Curb extension.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Built-in cant and mounting flange.
2. Overall Height:
3. Pitch Mounting: Manufacture curb for roof slope.
4. Metal Liner: Stainless steel.
5. Vented Curb: Unlined with louvered vents in vertical sides.

2.5 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install power ventilators level and plumb.

B. Equipment Mounting:

1. Support duct-mounted and other hanging ventilators directly from the building structure, using suitable hanging systems as specified in section 230529 “hangers and supports for HVAC piping and equipment”
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

E. Install curb support: Install ventilators on vibration isolation curbs and install flexible duct connectors and vibration isolation devices.

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inchhigh.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Div. 26 electrical specifications.

3.5 STARTUP SERVICE:

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor, and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Lubricate bearings.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections**.**

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.
3. Fans and components will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233423

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exhaust single-duct terminal units.
2. Casing liner.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For air terminal units.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Hangers and supports, including methods for duct and building attachment, and vibration isolation.

C. Delegated Design Submittal:

1. Materials, fabrication, assembly, and spacing of hangers and supports.
2. Include design calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and vibration isolation.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports shall withstand the effects of gravity and stresses within limits and under conditions described in SMACNA/s “HVAC Duct Construction Standards – Metal and Flexible” and ASCE/SEI 7.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Qualified Electrical Testing Laboratory, and marked for intended location and application.

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.3 SINGLE-DUCT VARIABLE AIR VOLUME CONTROL AIR TERMINAL UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Basis of Design: Price SDV.
2. Environmental Technologies, Inc.
3. Titus.
4. Nailor Industries, Inc.
5. Approved substitute.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 22-gauge zinc coated steel double wall.

1. Casing Lining: Adhesive attached, 3/4-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels, bottom mounted, for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wginlet static pressure.

E. Attenuator Section (where indicated in schedules): 0.034-inchsteel sheet.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

F. Direct Digital Controls: Factory mount actuator specified in Section 230900 "Instrumentation and Control for HVAC."

G. Control Sequence: See Drawings for control sequences.

2.4 EXHAUST SINGLE-DUCT TERMINAL UNITS

A. Manufacturer:

1. Basis of Design: Price SDV.

2. Approved substitute.

B. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud, for exhaust applications where pressurization control via exhaust and supply airflow control is desired.

C. Casing: Minimum 22-gauge-thick galvanized steel.

1. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
2. Air Outlet: S-slip and drive connections**,** size matching inlet size.
3. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2-percent of nominal airflow at 3-inch wginlet static pressure.

E. Attenuator Section: Casing material and thickness matching associated air terminal unit casing. Provide absorptive attenuator integral with the air terminal unit, of noise transmission loss performance as required in schedules on Drawings.

F. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent, controller and capacitor-discharge open actuator, and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.

a. Occupied and unoccupied operating mode.
b. Remote reset of airflow or temperature set points.
c. Adjusting and monitoring with portable terminal.

2. Room Sensor: Wall mounted with differential pressure set-point adjustment and access for connection of portable operator terminal.
3. Terminal Unit Controller, Controller is to be factory mounted and wired by air terminal manufacturer; unit controller, actuators, and room sensors are to be furnished under Section 230900 "Instrumentation and Control for HVAC."
4. Damper Actuator: 24 V, capacitor-discharge-return open.

G. Control Sequence: See Drawings for control sequences.

2.5 CASING LINER

A. Casing Liner, Fibrous Glass: Fibrous-glass duct liner, complying with ASTM C1071, NFPA 90A or NFPA 90B, and with NAIMA AH124.

1. Minimum Thickness: 1/2 inch.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 233113 "Metal Ducts" for hangers and supports.

B. Install air terminal units according to NFPA 90A.

C. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 PIPING CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

3.3 DUCTWORK CONNECTIONS

A. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.

B. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inchhigh.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Div. 26 electrical specifications.

3.6 IDENTIFICATION

A. Label each air terminal unit with drawing designation, nominal airflow, maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.7 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.8 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air terminal unit testing, adjusting, and balancing.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

B. Air terminal unit will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 233600

SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Round ceiling diffusers.
2. Rectangular and square ceiling diffusers.
3. Linear slot diffusers.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
2. Section 233713.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.
2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 ROUND CEILING DIFFUSERS

A. Manufacturers: Subject to compliance with requirements and performance, products by one of following manufacturer is acceptable

1. Titus (Basis Design)
2. Price Industries.
3. Krueger

B. Architectural round plaque ceiling diffusers shall be the Titus Model R-Omni of the sizes and mounting types shown on the plans and outlet schedule. Round outer cone shall be constructed of 18-gauge steel and heavy gauge aluminum plaque face. The exposed surface of the plaque shall be smooth and flat. The airflow discharge pattern shall be field adjusted from horizontal to vertical by repositioning the plaque assembly using the adjusting screws. The plaque assembly shall be constructed as a single inner assembly and must be easily removable using a spring lock mechanism.

C. Finish: The finish shall be #26 white.

1. The finish shall be an anodic acrylic paint, baked at 315ºF for 30 minutes.
2. The pencil harness must be HB to H.

D. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

2.2 RECTANGULAR AND SQUARE CEILING DIFFUSERS

A. Architectural square plaque ceiling diffusers

B. Manufacturers: Subject to compliance with requirements and performance, products by one of following manufacturer is acceptable

1. Titus (Basis Design)
2. Price Industries.
3. Krueger

C. Face Plate: shall be 22-gauge steel face panel, removable by means of four hanger brackets, exposed surface shall be smooth, flat, and free of visible fasteners, panel shall project no more than ¼ inch below the outside border of the diffuser back pan, the face panel plaque shall have an aerodynamically shaped, rolled edge to ensure a tight horizontal discharge pattern. A plaque without a rolled edge on the face panel will not be accepted. Ceiling diffusers with a 24 x 24-inch full face shall have no less than an 18 x 18-inch face panel size.

D. Back pan: shall be one piece precision die-stamped and shall include an integrally drawn inlet (welded-in inlets and corner joints are not acceptable). The diffuser back pan shall be constructed of 22-gauge steel.

E. Neck: shall have a minimum of 1¼-inch depth available for duct connection.

F. Finish: Standard finish shall be #26 white.

1. The standard finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes.
2. The pencil hardness must be HB to H.

2.3 LINEAR SLOT DIFFUSERS

A. Manufacturers: Subject to compliance with requirements and performance, products by one of following manufacturer is acceptable

1. Titus (Basis Design)
2. Price Industries.
3. Krueger

B. Provide all continuous linear slot and modular slot diffusers as shown on the drawings. The slot diffusers shall integrate into the ceiling system. Rolled or segmented linear slot diffusers will not be accepted.

C. The linear slot diffusers shall have a single slot unless shown otherwise and shall be capable of being used for supply air, return air, exhaust air or any combination there of.

D. The linear slot diffusers shall be capable of supporting the ceiling system. Linear diffusers supported by screws in the flanges or from air plenums are unacceptable. For lay-in ceiling, provide hanger wire support clips that are integral with the linear slot diffusers allowing the linear slot diffusers to be supported from the building structure with ceiling wire. For hard ceilings, provide clips that are integral with the linear slot diffusers allowing the diffusers to be secured directly to the ceiling framing without the requirement for hanger supports. Provide spline clips to secure joints and ceiling tees to the diffusers.

E. Provide ends and corners as required. Ends shall be butt type, field installed, or mitered picture frame type factory installed, as indicated herein or shown on the drawings. Corners shall be mitered one piece unit.

F. Pattern controllers shall be one-piece extruded aluminum, 24 inches long maximum, positioned between spring loaded spacers. Pattern controllers shall allow the airstream to be directed flat against the ceiling in either direction or downward as well as allowing throw reduction every two feet along the entire length of the linear slot diffusers. The airstream shall be maintained at the ceiling plane and shall not dump when volume is reduced. Only extruded aluminum pattern controllers are acceptable. Where shown or noted pattern controllers shall be designed to allow the airstream to be jetted into the occupied space and be adjustable to vector the airstream as required.

G. Material shall be minimum wall thickness 0.062 inches extruded aluminum. Spring steel retainers shall be used under the spacers to hold the slot diffusers assembly tightly together and allow the slot diffusers to be disassembled easily for field trimming. Materials other than extruded aluminum and spring steel will not be accepted.

H. Flanges exposed to view shall be painted factory standard white. All other surfaces shall be painted flat black. Provide paint samples if requested.

I. Plenums shall be minimum 24-gauge galvanized steel and lined inside with black matte fiberglass insulation. Hoods shall be 51 percent free area and constructed of 24-gauge perforated sheet metal painted flat black.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Adjustable blade face registers and grilles.
2. Eggcrate grilles.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
2. Section 233713.13 "Air Diffusers" for various types of air diffusers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.
2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 REGISTERS

A. Manufacturers: Subject to compliance with requirements and performance, products by one of following manufacturer is acceptable

1. Titus (Basis Design)
2. Price Industries.
3. Krueger

B. Steel supply grilles shall be TITUS Model 300R (double deflection)

1. The deflection blades shall be available parallel to the long dimension of the grille.
2. Construction shall be of steel with a 1¼-inch wide border on all sides.
3. Screw holes shall be countersunk for a neat appearance.
4. Corners shall be welded with full penetration resistance welds.

C. Deflection blades

1. Blades shall be spaced on ¾-inch centers.
2. Blades shall have steel friction pivots on both ends to allow individual blade adjustment without loosening or rattling. Plastic blade pivots are not acceptable.

D. The grille finish shall be #26 white.

1. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes.
2. The pencil hardness must be HB to H.

2.2 GRILLES

A. Manufacturers: Subject to compliance with requirements and performance, products by one of following manufacturer is acceptable

1. Titus (Basis Design)
2. Price Industries.
3. Krueger

B. Steel return grilles shall be TITUS Model 350R (¾-inch blade spacing)

1. The fixed deflection blades shall be available parallel to the long or short dimension of the grille.
2. Construction shall be of steel with a 1¼-inch wide border on all sides.
3. Screw holes shall be countersunk for a neat appearance.
4. Corners shall be welded with full penetration resistance welds.

C. Deflection blades

1. Blades shall be firmly held in place by mullions from behind the grille and fixed to the grille by welding in place. Blade deflection angle shall be available at 35°.

D. The grille finish shall be #26 white.

1. The finish shall be an anodic acrylic paint, baked at 315° F for 30 minutes.
2. The pencil hardness must be HB to H.

2.3 EGGCRATE GRILLE

A. Manufacturers: Subject to compliance with requirements and performance, products by one of following manufacturer is acceptable

1. Titus (Basis Design)
2. Price Industries.
3. Krueger

B. Return grilles shall be TITUS Model 50F.

1. Return grilles must provide a free area of at least 90%.
2. Outer borders shall be constructed of heavy extruded aluminum with a thickness of 0.040-0.050 inch and shall have countersunk screw holes for a neat appearance.
3. Border width shall be 1¼ inches on all sides and shall be interlocked at the four corners and mechanically staked to form a rigid frame.
4. aluminum grid: ½ x ½ x ½ inch

C. The grille finish shall be #26 white.

1. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes.
2. The pencil hardness must be HB to H.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

SECTION 233723 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Hooded ventilators.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product

B. Shop Drawings: For gravity ventilators.

1. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
2. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof-framing plans and other details, drawn to scale, and coordinated with each other, based on input from installers of the items involved:

1.5 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent

deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Snow Load: Unit to withstand a minimum of 20-lbf/sq. ft.snow load.

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

C. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

E. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

F. Capacities and Characteristics:

1. Drawing Tag No.: RH-106, RH-109, RH-126
2. Maximum Air Pressure Drop: Not more than 0.10-inch wgstatic pressure drop.
3. Function: Relief.

2.2 FABRICATION

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.3 GRAVITY VENTILATORS

A. Description: Low profile, hood for relief air.

B. Manufacturer:

1. Basis of Design: Greenheck GRSR
2. Approved Substitute.

C. Construction:

1. Hood:

   a. Constructed of aluminum.
   b. Internal structure is constructed of galvanized steel.

2. Birdscreeen:

   a. Constructed of ½ inch galvanized mesh.
   b. Mounted horizontally across the intake area of the hood.

3. Housing:

   a. Curb Cap type: Hinged.
   b. Constructed of aluminum, includes windband and curb cap. Galvanized material is not acceptable.
   c. Windband to be one piece spun aluminum construction and maintain original material thickness throughout the housing.
   d. Windband to include an integral rolled bead for strength.
   e. Curb cap to have integral deep spun inlet venturi and prepunched mounting holes to ensure correct attachment to roof.

4. Curb Seal:

   a. Rubber seal between fan and the roof curb.

5. Roof Curbs:

   a. Type: GPI.
   b. Mounted onto roof with fan.
   c. Material: Aluminum.

6. Dampers:

   a. Type: Motorized
   b. Prevents outside air from entering back into the building when fan is off.
   c. Balanced for minimal resistance to flow.
   d. Galvanized frames with prepunched mounting holes.

7. Finishes:

   a. Type: Baked Enamel.

8. Flashing Flange:

   a. Constructed of aluminum.
   b. Pre-punched holes for installation without a roof curb.

9. Hood Insulation:

a. Lined with ½ inch fiberglass insulation to prevent condensation and sound levels.

10. Insect Screen:

a. Constructed of fine mesh aluminum.
b. Fitted to the top of the throat and prevents entry of insects.

11. Tie-Down Points:

a. Four aluminum brackets located on windband secures fan in heavy wind applications.

2.4 SOURCE QUALITY CONTROL

A. AMCA Certification for Hooded Ventilators: Test, rate, and label gravity ventilators in accordance with AMCA 511.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Secure gravity ventilators to roof curbs with zinc-plated hardware. Use concealed anchorages where possible.

C. Install gravity ventilators with clearances for service and maintenance.

D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.

F. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes, so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

I. Refer to Division 07 for flashing and counterflashing of roof curbs.

3.2 DUCT CONNECTIONS

A. Duct installation and connection requirements are specified in Section 233113 "Metal Ducts". Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 233723

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Requirements:

1.2 SUMMARY

A. Section includes factory-assembled, dedicated outdoor air-handling units, including multiple components, capable of heating and cooling 100 percent outdoor air.

1.3 DEFINITIONS:

A. ECM: Electronically commutated motor.

1.4 ACTION SUBMITTALS

A. Product Data: For each dedicated outdoor-air unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

    a. Certified fan-performance curves with system operating conditions indicated.
    b. Certified fan-sound power ratings.
    c. Fan construction and accessories.
    d. Motor ratings, electrical characteristics, and motor accessories.

6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include heat exchangers with performance characteristics.
9. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each dedicated outdoor-air unit.

1. Include plans, elevations, sections, and mounting details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For Dedicated Outdoor-air unit supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators.
2. Detail mounting, securing, to base.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor/roof plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548.13 "Vibration Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control reports.

D. Startup service reports.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dedicated outdoor-air units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: one set for each unit.
2. Gaskets: One set for each access door.

1.8 WARRANTY

A. Warranty: Manufacturer agrees to replace components of dedicated outdoor-air units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Five years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. Capacities and characteristics

1. See mechanical schedules and drawings.

2.2 MANUFACTURER

A. Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design: Greenheck Fan Corporation.
2. Approved equivalent

2.3 MANUFACTURED UNITS

A. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, downturn outdoor air intake with 2” aluminum mesh filter assembly, condensate drain pan, P trap, Energy wheel, electric post-heater, packaged DX system, phase and brownout protection, motorized dampers, sensors, service receptacle, filter assembly for intake air, supply air blower assembly and an electrical control center. All specified components and internal accessories factory installed are tested and prepared for single-point high voltage connection except with electric post heat and exhaust fan only power which have dual point power.

2.4 CABINET

A. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.

1. Outside casing: 22 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Unit's exterior shall be supplied from the manufacturer using G60 galvaneal steel with a baked enamel finish.
2. Internal assemblies: 24 gauge, galvanized (G90) steel except for motor supports which shall be minimum14 gauge galvanized (G90) steel.

B. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.

1. Materials: Rigid urethane foam

a. Thickness: 2 inch (50.8 mm).
b. Thermal Resistance: R13.
c. Meets UL94HF-1 flame requirements.
d. Location and application: Full coverage of entire exterior to include walls, roof of unit, unit base and doors.

C. Access panels / doors: Unit shall be equipped with insulated, hinged doors or removable access panels to provide easy access to all major components. Doors and access panels shall be fabricated of 22-gauge galvanized G90 steel or painted galvannealed steel.

D. Supply Air blower assemblies: Blower assembly shall consist of an electric motor and direct-drive fan(s). Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125-inch-thick neoprene vibration isolators. Blower motor(s) shall be capable of continuous speed modulation and controlled by a VFD.

E. Control panel / connections: Rooftop Ventilator units shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections. RTU shall be equipped with a Unit Disconnect. Electric heater shall have single point power.

F. Condensate drain pan: Drain Pan shall be an integral part of the unit whenever a cooling option is included. Pan shall be formed of welded austenitic stainless steel sheet material and provided with a welded stainless steel drain connection at the front for connection to a P trap. Drain pan shall be sloped in two directions to provide positive draining and drain connector shall be sealed at penetration through cabinet wall.

G. P trap: If the unit is equipped with a condensate drain pan, contractor shall provide, or fabricate, and install an appropriate P trap, in accordance with all local and area codes and Best Practices. P trap must have electric heat tape for freeze protection. Provide drainpipe to approved receptacle for condensate.

H. Energy wheel: Unit energy wheel shall handle the full volume of outdoor and exhaust air without an energy wheel bypass damper(s). Energy wheel shall be of total enthalpy, rotary air-to-air type and shall be an element of a removable energy wheel cassette. The cassette shall consist of a galvanized steel framework (designed to produce laminar air flow through the wheel), an energy wheel as specified and a motor and drive assembly. The cassette shall incorporate a pre-tensioned urethane drive belt or a link style belt with a five-year warranty. The wheel media shall be a polymer film matrix in a stainless-steel framework and be comprised of individual segments that are removable for servicing. Non-segmented energy wheels are not

acceptable. Silica gel desiccant shall be permanently bonded to the polymer film and is designed and constructed to permit cleaning and servicing. The energy wheel is to have a five-year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.

I. Wheel Frost Control: Electric preheater: Shall be provided for frost control of the energy wheel. Preheater assembly shall include a thermostat and pressure sensor on the wheel assembly to initiate frost control sequence. Preheater shall comply with UL 1995 and be constructed on a galvanized steel frame.

J. Electric Post-heater: Post-heater shall be SCR control and shall include a temperature sensor with field adjustable set point, located in the outdoor air stream. Heat output of the post-heater shall be infinitely variable.

K. Packaged DX System: Unit shall have an integral compressor(s) and evaporator coil located within the weather-tight unit housing. Condenser coils and appurtenant condenser fan assemblies shall be factory installed as integral subassemblies of the unit and mounted with vibration isolation and as part of the unit. Unit condenser fans shall feature swept blade design resulting in reduced sound levels. Condenser fan motors shall be three phase, external rotor, type 56 frame, open air over and shaft up. Each condenser fan motor shall have a vented frame, rated for continuous duty and be equipped with an automatic reset thermal protector. Lead condenser fan will have an electronically commutated (EC) motor that will modulate to maintain a head pressure set point. Motors shall be UL Recognized and CSA Certified. The refrigerant compressor(s) shall be hermetic scroll-type and shall be equipped with liquid line filter drier, thermostatic expansion valves (TXV)(s), manual reset high pressure and low-pressure cutouts and all appurtenant sensors, service ports and safety devices. Compressed refrigerant system shall be fully charged with **required** refrigerant. Each compressor shall be factory-equipped with an electric crankcase heater to boil off liquid refrigerant from the oil.

L. Packaged DX Control and Diagnostics: The Packaged DX system shall be controlled by an onboard digital controller (DDC) that indicates both owner-supplied settings and fault conditions that may occur. The DDC shall be programmed to indicate the following faults:

1. Global alarm condition (active when there is at least one alarm).
2. Supply Air Proving alarm.
3. Dirty Filter alarm.
4. Compressor Trip alarm.
5. Compressor Locked Out alarm.
6. Supply Air Temperature Low Limit alarm.

    a. Sensor #1 Out of Range (outside air temperature).
    b. Sensor #2 Out of Range (supply air temperature).
    c. Sensor #3 Out of Range (cold coil leaving air temperature).

M. Phase and brownout protection: RTU shall have a factory-installed phase monitor to detect electric supply phase loss and voltage brown-out conditions. Upon detection of a fault, the monitor shall disconnect supply voltage to all motors.

N. Motorized dampers / Outdoor Air: AMCA Class 1A certified motorized damper of low leakage type and a leakage rate of 3 CFM/ft2 @ 1 in. wg. shall be factory installed.

O. Service receptacle: 120 VAC GFCI service outlet shall be factory-provided and installed by this contractor in a location designated by the A/E. Service outlet requires a dedicated single phase electric circuit. Unit contains a 120 VAC transformer to provide power to service outlet.

P. Hail guards: Protects the condensing unit from damage due to extreme weather conditions such as hail and flying debris.

Q. 24V/120V Smoke detector – Duct smoke detector is shipped loose for field mounting and wiring in the supply or return air duct. The air duct smoke detector housing shall be UL listed per UL 268A specifically for use in air handling systems. The air duct smoke detector housing shall be suitable for mounting indoors. The detector shall operate at air velocities of 100 feet per minute to 4000 feet per minute (0.5 to 20.32 meters/second). The power supply voltage shall be 20-29 VDC, 24 VAC 50-60 Hz, and 120 VAC 50-60 Hz. The detector shall consist of an alarm initiation contact & two DPDT auxiliary contact closures.

> WARNING: Duct smoke detectors are NOT a substitute for open area smoke detectors; NOT a substitute for early warning detection; NOT a replacement for a building's regular fire detection system. Refer to NFPA 72 and 90A for additional information.

2.5 BLOWER

A. Blower section construction Supply Air: direct drive motor(s) and blower(s) shall be assembled on a 14-gauge galvanized steel platform and shall be equipped with 1.125-inch-thick neoprene vibration isolation devices.

B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

C. Fan: Direct drive, airfoil plenum fan with steel wheels statically and dynamically balanced and AMCA certified for air and sound performance.

D. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating."

2.6 MOTORS

A. General: Blower motors greater than ¾ horsepower shall be "NEMA Premium™" unless otherwise indicated. Compliance with EPAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Motors shall be 60 cycles, 3 phase 460 volt.

2.7 UNIT CONTROLS

A. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats and sensors, or it can be operated as a heating and cooling system controlled by a Building Management System (BMS). This unit

shall be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors.

B. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices, or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable.

C. RTU supply fan shall be configured for network control.

D. Outside Air / Return Air damper control shall be network control.

E. Operating protocol: The DDC shall be factory-programmed for BACnet IP.

F. Variable Frequency Drive (VFD) unit shall have factory installed variable frequency drive for modulation of the supply air blower assembly. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.

G. Airflow monitoring required in the supply airstream.

2.8 FILTERS

A. Unit shall have permanent 2-inch (50.8 mm) aluminum mesh filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the supply air stream. MERV 13 disposable pleated filters shall be provided in the supply final air stream and MERV 8 filters in the exhaust air stream.

2.9 SOURCE QUALITY CONTROL

A. AHRI 1060 Certification: Testing according to AHRI 1060 and listed and labeled by AHRI.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical services to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices, and all applicable building codes.

B. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in section 230548.13 "Vibration control for HVAC"

3.3 CONNECTIONS

A. Connect duct to unit mounted on vibration isolators with flexible duct connectors.

B. Where installing piping adjacent to unit, allow space for service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Condensate Drain Piping: Pipe drains from drain pans to nearest floor drain; use ASTM D1785, Schedule 40 PVC pipe and solvent-welded fittings, same size as condensate drain connection.

E. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Div 26 electrical specifications.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Adjust seals and purge.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Set initial temperature and humidity set points.
5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, wheel rotation, and smooth bearing operations. Reconnect motor drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Clean entire unit, comb coil fins as necessary, and install clean filters.
7. Measure and record electrical values for voltage and amperage.

3.8 ADJUSTING

A. Comply with requirements for air-handling system testing, adjusting, and balancing in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 237433

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five years from date of First Day of Business (FDOB).
b. For Parts: Five years from date of First Day of Business (FDOB).
c. For Labor: Five years from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Daikin.
2. Mitsubishi.
3. LG HVAC.

2.2 INDOOR UNITS (5 TONSOR LESS)

A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:

    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
    c. Enclosure Type: Totally enclosed, fan cooled.
    d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

5. Air Filtration Section:

    a. Disposable Panel Filters:

        1) Factory-fabricated, viscous-coated, flat-panel type.
        2) Thickness: 2 inches.
        3) MERV according to ASHRAE 52.2: 8
        4) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
        5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS (5 TONSOR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a. Compressor Type: Scroll.
    b. Refrigerant: **R-32 or R-454B**.
    c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Fan: Aluminum-propeller type, directly connected to motor.
4. Motor: Permanently lubricated, with integral thermal-overload protection.
5. Low Ambient Kit: Permits operation down to 45 deg F.
6. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Drain Hose: For condensate.

2.5 CAPACITIES AND CHARACTERISTICS

A. Cooling Capacity:

1. Total: 48,000 Btu/h.
2. SEER: 20.2.
3. EER: 10.5.
4. Entering-Air Temperature:

    a. Dry Bulb: 101 deg F.

5. Leaving-Air Temperature:

    a. Dry Bulb: 55 deg F.

B. Heating Capacity:

1. None – Cooling only unit.

C. Indoor Unit:

1. Fan Motor Electrical Characteristics:

    a. Volts: 208 V ac.
    b. Phase: Single.
    c. Frequency: 60 Hz.

2. Airflow: 643 cfm.

D. Outdoor Unit:

1. Type: Air cooled.
2. Electrical Characteristics:

    a. Volts: 208.
    b. Phase: Single.
    c. Frequency: 60 Hz.
    d. Minimum Circuit Ampacity: 33.2 A.
    e. Maximum Overcurrent Protection: 35 A.
    f. Fan Motor Full-Load Amperes: 26.6 A.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 238129 - VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes complete VRF HVAC system(s) including, but not limited to, delegated design and the following components to make a complete operating system(s) according to requirements indicated:

1. Indoor, concealed, ceiling-mounted units for ducting.
2. Indoor, suspended, ceiling-mounted units.
3. Outdoor, air-source heat recovery units.
4. System controls.
5. System refrigerant and oil.
6. System condensate drain piping.
7. System refrigerant piping.
8. Metal hangers and supports.
9. Metal framing systems.
10. Fastener systems.
11. Pipe stands.
12. Equipment stands.
13. Miscellaneous support materials.
14. Piping and tubing insulation.
15. System control cable and raceways.

B. Related Requirements:

1. Section 232300 “Refrigerant Piping” for additional requirements.
2. Section 230529 “Hangers and Supports for HVAC Piping and Equipment”
3. Section 230719 “HVAC Piping Insulation”

1.3 DEFINITIONS

A. Heat Recovery System Operation: System capable of operation with simultaneous heating and cooling zones that transfer heat between zones.

B. HRCU: Heat Recovery Control Unit. HRCUs are used in heat recovery VRF HVAC systems to manage and control refrigerant between indoor units to provide simultaneous heating and cooling zones. "Heat Recovery Control Unit" is the term used by ASHRAE for what different

manufacturers term as branch circuit controller, branch selector box, changeover box, flow selector unit, mode change unit, and other such terms.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

E. Three-Pipe System Design: One high pressure refrigerant vapor line, one low pressure refrigerant vapor line, and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One liquid line and refrigerant vapor line connect HRCUs to associated indoor units.

F. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high- and low-pressure refrigerant between indoor units.

G. VRF: Variable refrigerant flow.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for HRCUs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and HRCU control.
6. Include refrigerant type and data sheets showing compliance with requirements indicated.

B. Shop Drawings: For VRF HVAC systems.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
5. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittals:

1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.
2. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.
3. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.
4. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural floors, roofs and associated members to which equipment, piping, ductwork, cables, and conduit will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
5. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.
6. Items penetrating finished ceiling including the following:

    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Service access panels.

B. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

    a. Retain copies of Installer certificates on-site and make available on request.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters:

a. One set for each unit with replaceable filters.

2. Controllers for Indoor Units: One for each unique controller type installed.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. VRF HVAC systems and products that have been successfully tested and in use on at least five completed projects.
3. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.

B. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
2. Service and maintenance staff assigned to support Project during warranty period.
3. Product parts inventory to support ongoing system operation for a period of not less than five years after First Day of Business (FDOB).
4. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period:

a. For Compressor: Seven years from date of First Day of Business (FDOB).
b. For Parts, Including Controls: one year from date of First Day of Business (FDOB).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design: Daikin Comfort Technologies, Inc.
2. Approved equivalent

B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

1. Indoor and outdoor units, including accessories.
2. Controls and software.

3. HRCUs.
4. Refrigerant isolation valves.
5. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, HRCUs, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.

1. Two-pipe or three-pipe system design.
2. System(s) operation, heat recovery as indicated on Drawings.
3. Each system with one refrigerant circuit shared by all indoor units connected to system.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.

D. ASHRAE Compliance:

1. ASHRAE 15: For safety code for mechanical refrigeration.
2. ASHRAE 62.1: For indoor air quality.
3. ASHRAE 135: For control network protocol with remote communication.
4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional specialist, as defined in Section 014000 "Quality Requirements," to design complete and operational VRF HVAC system(s) complying with requirements indicated.

1. Provide system refrigerant calculations.

a. Refrigerant concentration limits shall be within allowable limits of ASHRAE 15 and governing codes.
b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.

2. System Refrigerant Piping and Tubing:

a. Arrangement: Arrange piping to interconnect indoor units, HRCUs, and outdoor unit(s) in compliance with manufacturer requirements and requirements indicated.

b. Routing: Conceal piping above ceilings and behind walls to maximum extent possible.
c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated. Consider requirements to accommodate future change requirements.

3. System Controls:

a. Network arrangement.
b. Network interface with other building systems.
c. Product selection.
d. Sizing.

B. Service Access:

1. Provide and document service access requirements.
2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.
5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
6. Comply with OSHA regulations.

C. System Design and Installation Requirements:

1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.

D. Isolation of Equipment: Provide isolation valves to isolate each HRCU, indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.

E. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor unit rated capacity:

1. Range acceptable to manufacturer.

F. System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.

G. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.

H. Outdoor Conditions:

1. Suitable for outdoor ambient conditions encountered.

a. Design equipment and supports to withstand wind loads of governing code.
b. Design equipment and supports to withstand snow and ice loads of governing code.
c. Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.

I. Capacities and Characteristics: As indicated on Drawings.

2.4 INDOOR, CONCEALED, CEILING-MOUNTED UNITS FOR DUCTING

A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:

1. Material: Galvanized steel.
2. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

    a. Direct-drive arrangement.
    b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
    c. Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.
    d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
2. Efficiency: ASHRAE 52.2, MERV 13.
3. Media:

    a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

G. Unit Accessories:

1. **Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit.**

H. Unit Controls:

1. Enclosure: Metal, suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:

    a. Unit inlet air temperature.
    b. Coil entering refrigerant temperature.
    c. Coil leaving refrigerant temperature.

4. Features and Functions:

    a. Self-diagnostics.
    b. Time delay.
    c. Auto-restart.
    d. Auto operation mode.
    e. Manual operation mode.
    f. Filter service notification.
    g. Power consumption display.
    h. Run test switch.

5. Communication: Network communication with other indoor and outdoor units.
6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

I. Unit Electrical:

1. Enclosure: Metal, suitable for indoor locations.
2. Field Connection: Single point connection to power unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in raceways.

2.5 INDOOR, EXPOSED, WALL-MOUNTED UNITS

A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.

2. Condensate Removal: Gravity.

    a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.

3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

    a. Direct-drive arrangement.
    b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
    c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
    d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Front, to accommodate filter replacement without the need for tools.
2. Efficiency: ASHRAE 52.2, MERV 13.
3. Washable Media: Manufacturer's standard filter with antimicrobial treatment.

G. Grille Assembly: Manufacturer's standard discharge grille mounted in top or front face of unit cabinet.

H. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.

I. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Features and Functions: Self-diagnostics, time delay, auto-restart.
4. Communication: Network communication with other indoor units and outdoor unit(s).
5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

J. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

2.6 INDOOR, RECESSED, CEILING-MOUNTED UNITS

A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Internal Tubing: Copper tubing with brazed joints.
6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

    a. Direct-drive arrangement.
    b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
    c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
    d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Bottom, to accommodate filter replacement without the need for tools.
2. Efficiency: ASHRAE 52.2, MERV 13.
3. Media:

    a. Washable: Manufacturer's standard filter with antimicrobial treatment.

G. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.

1. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.

    a. Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
    b. Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.

2. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.

H. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.

I. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.

J. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

K. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors: Unit inlet air temperature.

4. Features and Functions: Self-diagnostics, time delay, auto-restart.
5. Communication: Network communication with other indoor units and outdoor unit(s).
6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

L. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

2.7 INDOOR, SUSPENDED, CEILING-MOUNTED UNITS

A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Internal Tubing: Copper tubing with brazed joints.
6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Gravity.

    a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.

3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

    a. Direct-drive arrangement.
    b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
    c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
    d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Front, to accommodate filter replacement without the need for tools.
2. Efficiency: ASHRAE 52.2, MERV 13
3. Washable Media: Manufacturer's standard filter with antimicrobial treatment.

G. Discharge-Air Grille Assembly: Mounted in front of unit cabinet.

1. Discharge Pattern: One-way throw.
2. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.

H. Return-Air Grille Assembly: Manufacturer's standard.

I. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.

J. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.

3. Communication: Network communication with other indoor units and outdoor unit(s).
4. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
5. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

K. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

2.8 OUTDOOR, AIR-SOURCE HEAT RECOVERY UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. All units installed shall be from the same product development generation.

B. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.
2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:

a. High refrigerant pressure.
b. Low oil level.
c. High oil temperature.
d. Thermal and overload.
e. Voltage fluctuations.
f. Phase failure and phase reversal.
g. Short cycling.

3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

D. Condenser Coil Assembly:

1. Plate Fin Coils:

a. Casing: Aluminum, galvanized, or stainless steel.
b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
c. Tubes: Copper, of diameter and thickness required by performance.

E. Condenser Fan and Motor Assembly:

1. Fan(s): Propeller type.

a. Direct-drive arrangement.
b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
c. Statically and dynamically balanced.

2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
5. Speed Settings and Control: Variable speed.
6. Vibration Control: Integral isolation to dampen vibration transmission.

F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

G. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:

a. Refrigerant suction temperature.
b. Refrigerant discharge temperature.
c. Outdoor air temperature.
d. Refrigerant high pressure.
e. Refrigerant low pressure.
f. Oil level.

4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, night setback control.
5. Communication: Network communication with indoor units and other outdoor unit(s).
6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

H. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

I. Unit Hardware: Zinc-plated steel, or stainless steel.

J. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.9 HEAT RECOVERY CONTROL UNITS (HRCUs or BSs)

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.

B. Cabinet:

1. Galvanized-steel construction.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

D. Refrigeration Assemblies and Specialties:

1. Specially designed by manufacturer for type of VRF HVAC system being installed, either two or three pipe.
2. Each refrigerant branch circuit shall have refrigerant control valve(s) to control refrigerant flow.
3. Spares: Each heat recovery control unit shall include at least two branch circuit port(s) for future use.
4. Each system piping connection upstream of heat recovery unit shall be fitted with an isolation valve to allow for service to any heat recovery control unit in the system without interrupting operation of the system.
5. Each branch circuit connection shall be fitted with an isolation valve and capped service port to allow for service to any individual branch circuit without interrupting operation of the system.

    a. If not available as an integral part of the heat recovery control unit, isolation valves shall be field installed adjacent to the unit pipe connection.

E. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Features and Functions: Self-diagnostics, fuse protection.
4. Communication: Network communication with indoor units and outdoor unit(s).
5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

F. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

G. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.

4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.10 SYSTEM CONTROLS

A. General Requirements:

1. Network: Indoor units, HRCUs, and outdoor units shall include integral controls and connect through a manufacturer-selected control network.
2. Network Communication Protocol: Manufacturer proprietary or open control communication between interconnected units.
3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL).
4. Operator Interface:

    a. Operators shall interface with system and unit controls through the following:

        1) Operator interfaces integral to controllers.
        2) Web interface through web browser software.
        3) Integration with Building Automation System.

    b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:

        1) On/off control.
        2) Temperature set-point adjustment.

B. VRF HVAC System Operator Software for PC:

1. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.
2. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
7. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
8. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.

9. Displays service notifications and error codes.
10. Monitors and displays up to 3000 item error history and 10000 item operation history for regular reporting and further archiving.
11. Monitors and displays cumulative operating time of indoor units.
12. Able to disable and enable operation of individual controllers for indoor units.
13. Information displayed on individual controllers shall also be available for display.
14. Information displayed for outdoor units, including refrigerant high and low pressures.

C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.

    a. Include multiple interconnected controllers as required.

2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

    a. Sets schedule for daily, weekly, and annual events.
    b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.

4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Service diagnostics tool.
8. Able to disable and enable operation of individual controllers for indoor units.
9. Information displayed on individual controllers shall also be available for display through central controller.
10. Information displayed for outdoor units, including refrigerant high and low pressures.
11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
12. Operator interface through a backlit, high-resolution color display touch panel and web accessible through standard web browser software].

D. Wired Controllers for Indoor Units:

1. Single controller capable of controlling multiple indoor units as group.
2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
3. Temperature Units: Fahrenheit.
4. On/Off: Turns indoor unit on or off.
5. Hold: Hold operation settings until hold is released.
6. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
7. Temperature Display: 1-degree increments.

8. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments.
9. Fan Speed Setting: Select between available options furnished with the unit.
10. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
11. Seven-day programmable operating schedule with up to eight events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
12. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
13. Occupancy detection.

E. Wireless Controllers for Indoor Units:

1. Wireless Communication:

a. Controller communicates to remote-mounted receiver that is wired to indoor unit(s).

1) Include receivers with wireless controllers as required to complete installation.
2) Low-voltage power required for receivers shall be powered through non-polar connections to indoor unit.

b. One wireless controller shall be capable of communicating with one or multiple receivers to control one or multiple indoor units as a group.

2. Controller Battery Life: Three years.
3. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
4. Temperature Units: Fahrenheit.
5. On/Off: Turns indoor unit on or off.
6. Hold: Hold operation settings until hold is released.
7. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
8. Temperature Display: 1-degree increments.
9. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree.
10. Fan Speed Setting: Select between available options furnished with the unit.
11. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
12. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.

2.11 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
2. ASHRAE 34, **Class A2L** refrigerant classification.
3. **R-32 or R-454B**.

B. Oil:

1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

2.12 SYSTEM CONDENSATE DRAIN PIPING

A. If more than one material is listed, material selection is Contractor's option.

B. Copper Tubing:

1. Drawn-Temper Tubing: According to ASTM B88, Type L or Type DWV according to ASTM B306.
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B32, lead-free alloys, and water-flushable flux according to ASTM B813.

C. CPVC plastic pipe according to ASTM F441/F441M, Schedule 40, with socket-type pipe fittings according to ASTM F438 and solvent cement according to ASTM F493.

D. PVC plastic pipe according to ASTM D1785, Schedule 40, with socket-type pipe fittings according to ASTM D2466 and solvent cement according to ASTM D2564, primer according to ASTM F656.

2.13 SYSTEM REFRIGERANT PIPING

A. Comply with requirements in Section 232300 "Refrigerant Piping" for system piping requirements.

B. Refrigerant Piping:

1. Copper Tube: ASTM B280, Type ACR.
2. Wrought-Copper Fittings: ASME B16.22.
3. Brazing Filler Metals: AWS A5.8/A5.8M.

C. Refrigerant Tubing Kits:

1. Furnished by VRF HVAC system manufacturer.
2. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.
3. Standard one-piece length for connecting to indoor units.
4. Pre-insulated with flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.
5. Factory Charge: Dehydrated air or nitrogen.

D. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.

E. Refrigerant Isolation Ball Valves:

1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.
3. Valve Connections: Flare or sweat depending on size.

2.14 METAL HANGERS AND SUPPORTS

A. Copper Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized or copper-coated steel.

B. Plastic Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, galvanized-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.

2.15 OUTDOOR EQUIPMENT STANDS

A. Description: Individual foot supports with elevated adjustable channel cross bars and clamps/fasteners/bolts for ground or roof-supported outdoor equipment components, without roof membrane penetration, in a prefabricated system that can be modularly assembled on-site.

B. Foot Material: Rubber or polypropylene.

C. Rails Material: Hot-dip galvanized carbon steel.

D. Wind/Sliding Load Resistance: Up to 100 mph minimum.

2.16 MISCELLANEOUS SUPPORT MATERIALS

A. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

B. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

C. Threaded Rods: Continuously threaded. Zinc-plated steel or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar material as rods.

2.17 PIPING AND TUBING INSULATION

A. Comply with requirements in Section 230719 "HVAC Piping Insulation" for system piping insulation requirements.

B. Condensate Drain Piping and Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:

a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
b. Indoors: 1/2 inch thick.
c. Outdoors: 1 inch thick.

2. Field-Applied Jacket:

a. Concealed: None required.
b. Indoors, Exposed to View: PVC or ASJ, color selected by Architect, 20 mils thick.
c. Outdoors, Exposed to View: None required.

C. Refrigerant Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:

a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
b. Indoors: 1 inch thick.
c. Outdoors: 1 inch thick.

2. Field-Applied Jacket:

a. Concealed: None required.
b. Indoors, Exposed to View: PVC or ASJ, color selected by Architect, 20 mils thick.
c. Outdoors, Exposed to View: Aluminum, smooth, 0.020 inchthick.

D. Flexible Elastomeric Insulation Adhesive: Comply with MIL-A-24179A, Type II, Class I.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

F. Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

2.18 SYSTEM CONTROL CABLE

A. Cable Rating: Listed and labeled for application according to NFPA 70.

1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

    a. Flame Travel Distance: 60 inches or less.
    b. Peak Optical Smoke Density: 0.5 or less.
    c. Average Optical Smoke Density: 0.15 or less.

2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
3. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

B. Low-Voltage Control Cabling:

1. Paired Cable: NFPA 70, Type CMG.

    a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
    b. PVC insulation.
    c. Braided or foil shielded.
    d. PVC jacket.
    e. Flame Resistance: Comply with UL 1685.

2. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

    a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
    b. PVC insulation.
    c. Braided or foil shielded.
    d. PVC jacket.
    e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.
    f. Flame Resistance: Comply with NFPA 262.

C. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for control wiring and cable raceways.

2.19 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

2.20 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect factory-assembled equipment.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:

1. Maintain manufacturer's recommended clearances for service and maintenance.
2. Maintain clearances required by governing code.

B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.

1. Loose components shall be installed by system Installer under supervision of manufacturer's service representative.

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch.

C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch.

H. For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.

I. Attachment: Install hardware for proper attachment to supported equipment.

J. Grouting: Place grout under equipment supports and make bearing surface smooth.

3.4 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Install outdoor units on support structures indicated on Drawings.

C. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

1. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment. Follow manufacturer's recommended installation instruction. Provide vibration isolate at attachment per 230548.13.
2. Grouting: Place grout under equipment supports and make bearing surface smooth.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping and tubing to permit valve servicing.

F. Install piping and tubing at indicated slopes.

G. Install piping and tubing free of sags.

H. Install fittings for changes in direction and branch connections.

I. Install piping and tubing to allow application of insulation.

J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors.

3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.
2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:

a. Details indicated on Drawings.
b. Manufacturer's requirements.
c. Governing codes.
d. In the absence of requirements, comply with requirements of ASHRAE handbooks.

4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of not less than two percent.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.7 INSTALLATION OF REFRIGERANT PIPING

A. Refrigerant Tubing Kits:

1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.
2. Support tubing using hangers and supports indicated at intervals not to exceed 5 feet. Minimum rod size, 1/4 inch.
3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.

B. Install refrigerant piping according to ASHRAE 15 and governing codes.

C. Select system components with pressure rating equal to or greater than system operating pressure.

D. Install piping as short and direct as possible, with a minimum number of joints and fittings.

E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

F. Install refrigerant piping and tubing in protective conduit where installed belowground.

G. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

H. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:

1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps to entrain oil in vertical runs.
4. Liquid lines may be installed level.

I. When brazing, remove or protect components that could be damaged by heat.

J. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

K. Joint Construction:

1. Ream ends of tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
3. Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.8 INSTALLATION OF METAL HANGERS AND SUPPORTS

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

C. Comply with MFMA-103 for metal framing system selections and applications that are not specified.

D. Fastener System Installation:

1. Install powder-actuated fasteners, for use in lightweight concrete or concrete slabs less than 4 inches thick, in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

3. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel.

1. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

K. Piping and Tubing Insulation:

1. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
2. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

L. Horizontal-Piping Hangers and Supports: Install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
3. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
4. Multiple horizontal pipes located indoors may use metal framing systems with split clamp attachment for each pipe in lieu if individual clevis hangers.
5. Pipe stands for horizontal pipes located outdoors.
6. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
7. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

M. Horizontal Piping Hanger Spacing and Rod Size: Install hangers for drawn-temper copper piping with the following maximum horizontal spacing and minimum rod sizes:

1. Sizes through NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

N. Plastic Pipe Hanger and Support Spacing:

1. Space hangers and supports according to pipe manufacturer's written instructions for service conditions.
2. Maximum spacing, 5 feet; minimum rod size, 1/4 inch.

O. Vertical-Piping Clamps: Install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): If longer ends are required for riser clamps.

P. Support vertical runs at roof, at each floor, and at midpoint intervals between floors, not to exceed 10 feet.

Q. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified.

R. Use hangers, supports, and attachments with galvanized coatings unless otherwise indicated.

S. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

T. Trim excess length of continuous-thread hanger and support rods to 1 inch

U. Hanger-Rod Attachments: Install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

V. Building Attachments: Install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

3.9 INSTALLATION OF PIPING AND TUBING INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Installation to maintain a continuous vapor barrier.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

E. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 INSTALLATION OF DUCT, ACCESSORIES, AND AIR OUTLETS

A. Where installing ductwork adjacent to equipment allow space for service and maintenance.

B. Comply with requirements for metal ducts specified in Section 233113 "Metal Ducts."

C. Comply with requirements for air duct accessories specified in Section 233300 "Air Duct Accessories."

D. Comply with requirements for flexible ducts specified in Section 233346 "Flexible Ducts."

E. Comply with requirements for air diffusers specified in Section 233713.13 "Air Diffusers."

F. Comply with requirements for registers and grilles specified in Section 233713.23 "Registers and Grilles."

3.11 ELECTRICAL INSTALLATION

A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.

B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.

1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.

C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

E. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

F. Install nameplate or acrylic label with self-adhesive back for each electrical connection indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated phenolic layers of black with engraved white letters. Letters at least 1/2 inch high.

2. Locate nameplate or label where easily visible.

G. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or revised in this Section.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

H. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

I. Install manufactured conduit sweeps and long-radius elbows if possible.

J. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.12 SOFTWARE

A. Cybersecurity:

1. Software:

a. Coordinate security requirements with IT department.
b. Ensure that latest stable software release is installed and properly operating.
c. Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols at least eight characters in length. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:

a. Coordinate location and access requirements with IT department.
b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
c. Disable dual network connections.

3.13 INSTALLATION OF SYSTEM CONTROL CABLE

A. Comply with NECA 1.

B. Installation Method:

1. Install cables in raceways except as follows:

a. Within equipment and associated control enclosures.
b. In accessible ceiling spaces where open cable installation method may be used.
c. In gypsum board partitions where cable may be enclosed within wall cavity.

2. Conceal raceway and cables except in unfinished spaces.

C. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable.
5. Cables serving a common system may be grouped in a common raceway. Install control cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles or access panels.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals.
15. Do not bend cables in a radius less than 10 times the cable OD.
16. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
17. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

D. Balanced Twisted-Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Do not untwist balanced twisted-pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

E. Open-Cable Installation:

1. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inchesapart.
2. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources: Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded cable from potential EMI sources including electrical power wiring and equipment.

3.14 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.15 GROUNDING INSTALLATION

A. For low-voltage control cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.16 IDENTIFICATION

A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 230553 "Identification for HVAC Piping and Equipment."

B. Identify system electrical and controls components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.

3.17 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

a. First Visit: Kick-off meeting.
b. Second Visit: At approximately 50 percent completion of system(s).
c. Third Visit: Final inspection before system startup.

2. Kick-off Meeting:

a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
c. Meeting shall cover the following as a minimum requirement:

1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
2) Manufacturer's installation requirements specific to systems being installed.
3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
4) Required field activities related installation of VRF HVAC system.
5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.

3. Site Visits: Activities for each site visit shall include the following:

a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
d. Advise and if necessary, assist Installer with updating related refrigerant calculations and system documentation.
e. Issue a report for each visit, documenting the visit.

1) Report to include name and contact information of individual making the visit.
2) Date(s) and time frames while on-site.
3) Names and contact information of people meeting with while on-site.
4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

4. Final Inspection before Startup:

a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according to manufacturer's requirements and ready for final inspection.
b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
d. Inspection reports for indoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.

5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity settings and readings within an acceptable range.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Unit airflow direction within an acceptable range.
19) If applicable, fan external static pressure setting.
20) Filter type and condition acceptable.
21) Noise level within an acceptable range.
22) Refrigerant piping properly connected and insulated.
23) Condensate drain piping properly connected and insulated.
24) If applicable, ductwork properly connected.
25) If applicable, external interlocks properly connected.
26) Remarks.

e. Inspection reports for outdoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Condensate removal acceptable.
13) Noise level within an acceptable range.
14) Refrigerant piping properly connected and insulated.
15) Condensate drain piping properly connected and insulated.
16) Remarks.

f. Installer shall provide manufacturer with the requested documentation and technical support during inspection.
g. Installer shall correct observed deficiencies found by the inspection.
h. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.

i. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
j. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.2 times VRF HVAC system operating pressure, but not less than 600 psig, using dry nitrogen.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
4. Prepare test report to record the following information for each test:

a. Name of person starting test, company name, phone number, and e-mail address.
b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
c. Detailed description of extent of tubing tested.
d. Date and time at start of test.
e. Test pressure at start of test.
f. Outdoor temperature at start of test.
g. Name of person ending test, company name, phone number, and e-mail address.
h. Date and time at end of test.
i. Test pressure at end of test.
j. Outdoor temperature at end of test.
k. Remarks:

5. Submit test reports for Project record.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.

2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour with no change.
4. Prepare test report to record the following information for each test:

    a. Name of person starting test, company name, phone number, and e-mail address.
    b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
    c. Detailed description of extent of tubing tested.
    d. Date and time at start of test.
    e. Test pressure at start of test.
    f. Outdoor temperature at start of test.
    g. Name of person ending test, company name, phone number, and e-mail address.
    h. Date and time at end of test.
    i. Test pressure at end of test.
    j. Outdoor temperature at end of test.
    k. Remarks:

5. Submit test reports for Project record.
6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
3. System refrigerant charging shall be witnessed by system manufacturer's representative.
4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.18 STARTUP SERVICE

A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.

1. Service representative shall be an employee or a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
2. Complete startup service of each separate system.
3. Complete system startup service according to manufacturer's written instructions.

B. Startup checks shall include, but not be limited to, the following:

1. Check control communications of equipment and each operating component in system(s).
2. Check each indoor unit's response to demand for cooling and heating.
3. Check each indoor unit's response to changes in airflow settings.
4. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.
5. Check sound levels of each indoor and outdoor unit.

C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:

1. After completion of startup service, manufacturer shall issue a report for each separate system.
2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.

a. All available system operating parameters shall be included in the information submitted.

E. Adjust equipment and components to function smoothly and lubricate as recommended by manufacturer.

F. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.

G. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

H. Occupancy Adjustments: When requested within 12 months from date of First Day of Business (FDOB), provide on-site assistance in adjusting system to suit actual occupied conditions.

3.19 PROTECTION

A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.

B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.

C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.

D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.20 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of system Installer who are manufacturer's authorized service representative. Include four service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.21 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within 5 years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.22 DEMONSTRATION

A. Engage a VRF HVAC system manufacturer's employed training instructor or factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Instructor:

1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.
2. Instructor(s) sole job responsibility shall be Owner training.
3. Instructor(s) shall have not less than three years of training experience with VRF HVAC system manufacturer and past training experience on at least three projects of comparable size and complexity.

C. Schedule and Duration:

1. Schedule training with Owner at least 20 business days before first training session.
2. Training shall occur before Owner occupancy.
3. Training shall be held at mutually agreed date and time during normal business hours.
4. Each training day shall not exceed eight hours of training. Daily training schedule shall allow time for one-hour lunch period and 15-minute break after every two hours of training.
5. Perform not less than eight total hours of training.

D. Location: Owner shall provide a suitable on-site location to host classroom training.

E. Training Attendees: Assume two people.

F. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.

G. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.

H. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

I. Acceptance: Obtain Commissioning Agent or Owner written acceptance that training is complete, and requirements indicated have been satisfied.

END OF SECTION 238129

SECTION 238216.14 - ELECTRIC-RESISTANCE AIR COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Electric-resistance air coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Coil Assembly: Comply with UL 1995.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

D. Equally balance heater electrical load for each step across all electrical phases.

E. Part-Load Operation: Provide arrangement with operation staged for uninterrupted operation over the full range of airflow down to the minimum airflow indicated.

F. Capacities and Characteristics:

1. Coil Face Dimensions:

a. Length: 28 inches.
b. Height: 24 inches.

2. Mounting: Slip in.
3. Air Side:

a. Flow Rate: 3025 CFM.
b. Face Velocity: 650 fpm.
c. Entering Temperature: 45.8 deg F.
d. Leaving Temperature: 77.3 deg F.

4. Electrical Characteristics:

a. Capacity: 23 kW.
b. Number of Steps: SCR.
c. Volts: 480.
d. Phase: 3.
e. Hertz: 60.
f. Full-Load Amperes: 27.9.
g. Minimum Circuit Ampacity: 34.9.
h. Maximum Overcurrent Protection: 35.

2.2 ELECTRIC-RESISTANCE AIR COILS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Greenheck Corporation.
2. Nailor Industries.
3. Marley Engineered Products.
4. Indeeco Heating Solutions.

B. Source Limitations: Obtain electric-resistance air coils from single source from single manufacturer.

C. Heating Elements:

1. Open Elements:

    a. Open-coil resistance wire of 80 percent nickel and 20 percent chromium; supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in a frame.
    b. Safety Screens: Install safety screens to protect operators from accidentally coming into direct connect with elements.

D. Frame: Galvanized steel; minimum 0.052 inchthick for slip-in mounting. Include intermediate element support brackets equally spaced at a maximum of 36 incheso.c. across electric-resistance air coil.

E. Terminal Box/Control Panel: Unit mounted; with disconnection means and overcurrent protection.

1. Enclosure: NEMA 250, Type 1enclosure complying with UL 50.
2. Full-face-hinged door.
3. Install a laminated elementary wiring diagram on inside face of heater control panel door or in another protected location than visible be service personnel. Wiring diagram to match installation.

F. Controls:

1. Safety Controls: Each heater is to be provided with the following factory-mounted safety controls:

    a. Disk-type thermal cutout switch with automatic reset.
    b. Primary linear thermal limit cutout switch with automatic reset.
    c. Secondary linear thermal limit cutout switch with local manual reset.
    d. Airflow Proving Switch: Pressure differential type; with pressure range selected to ensure reliable operation throughout full range of air-handling unit airflow down to minimum airflow indicated.

2. SCR Control: Silicone-controlled rectifier (SCR) for 100 percent stepless capacity control.

    a. Heater on/off control.
    b. Monitoring heater on/off status.
    c. High-temperature alarm.
    d. Low-airflow alarm.
    e. Heater capacity control.

G. Electrical:

1. Single-Point Field Power Connection: Install and wire the heater to accommodate a single field electrical connection for electrical power.
2. Disconnecting Means: Provide each heater with a main electrical power connection, door mounted and interlocking, and disconnecting means to prevent access into panel, unless switched to the off position.

a. Fused disconnect switch with lockable handle.

3. Factory install and wire branch circuit fusing or circuit breakers in accordance with NFPA 70.
4. Pilot Lights: Include labeled pilot lights on face of control panel for the following:

a. Power on.

5. Terminations: Wire terminations and field interface terminations to labeled terminal strips.
6. Control Transformer: Size control circuit transformer for load.
7. Labeling: Label each electrical device with a laminated phenolic tag.
8. Use only NRTL-labeled electrical components.

H. Nameplate: Include the following data:

1. Manufacturer name, address, telephone number, and website address.
2. Manufacturer model number.
3. Serial number.
4. Manufacturing date.
5. Coil identification (indicated on Drawings).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inchhigh.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Div. 26 electrical specifications.

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Prepare test and inspection reports.

END OF SECTION 238216.14

SECTION 238239.19 - WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details of anchorages and attachments to structure and to supported equipment.
4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
5. Wiring Diagrams: Power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Reznor.

B. Qmark

C. Accepted substitutions.

2.2 DESCRIPTION

A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

A. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.

B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COIL

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection.

2.5 FAN AND MOTOR

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: Permanently lubricated. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.6 CONTROLS

A. Controls: Unit-mounted thermostat.

B. Electrical Connection: Factory wire motors and controls for a single field connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 238239.19

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Fire Rated Sleeves for cables.
4. Grout.
5. Common electrical installation requirements.
6. Utility company coordination requirements.

1.3 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. 8PSJ or 8P8C: Miniature 8-position series jack, also called an 8-position 8-contact modular jack for some applications.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AF : Amp Frame
5. AFCI: Arc-fault circuit interrupter.
6. AIC: Ampere interrupting capacity.
7. AL, Al, or ALUM: Aluminum.
8. AP: Wireless access point
9. ASD: Adjustable-speed drive.
10. AT: Amp Trip
11. ATS: Automatic transfer switch.
12. AV: Audio-Video, audio-visual
13. AWG: American wire gauge; see ASTM B258.
14. BAS: Building automation system.
15. BIL: Basic impulse insulation level.
16. BIM: Building information modeling.
17. BJ: Bonding jumper
18. BKR: Breaker
19. BMS: Building Management System
20. C: Conduit

21. CAD: Computer-aided design or drafting.
22. CATV: Community antenna television, Cable Television
23. CB: Circuit breaker.
24. CCTV: Closed circuit television
25. CFCI: Contractor furnished contractor installed
26. CKT: Circuit
27. CO/ALR: Copper-aluminum, revised.
28. COPS: Critical operations power system.
29. CU or Cu: Copper.
30. CU-AL or AL-CU: Copper-aluminum.
31. dB or DB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
32. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
33. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
34. dBm: Decibel absolute power with respect to 1 mW.
35. DC or dc: Direct current.
36. DCOA: Designated critical operations area.
37. DDC: Direct digital control (HVAC).
38. DISC: Disconnect
39. DP: Distribution Panelboard
40. DW: Dishwasher
41. ECS: Emergency communication system
42. EGB: Electrical grounding busbar
43. EGC: Equipment grounding conductor.
44. EMD: Estimated maximum demand.
45. EMGB: Electrical main grounding busbar
46. EMF: Electromotive force.
47. EMI: Electromagnetic interference.
48. EP: Explosion proof
49. EPM: Electrical preventive maintenance.
50. EPS: Emergency power supply.
51. EPSS: Emergency power supply system.
52. ER: Existing to be relocated
53. ERMS: Energy reduction maintenance switch
54. ESS: Energy storage system.
55. EV: Electric vehicle.
56. EVPE: Electric vehicle power export equipment.
57. EVSE: Electric vehicle supply equipment.
58. EWC: Electric water cooler
59. FA: Fire Alarm
60. FAA: Fire alarm annunciator
61. FACP: Fire alarm control panel
62. FC or fc: Footcandle, a unit of illuminance equal to one lumen per square foot.
63. FLA: Full load amps
64. FLC: Full-load current.
65. FS: Flow Switch
66. FSD: Fire smoke damper
67. ft.: Foot.

68. G or GND: Equipment grounding conductor
69. GEC: Grounding electrode conductor.
70. GEN: Generator
71. GFI or GFCI: Ground-fault circuit interrupter.
72. GFPE: Ground-fault protection of equipment.
73. GND: Ground.
74. HACR: Heating, air conditioning, and refrigeration.
75. HDPE: High-density polyethylene.
76. HID: High-intensity discharge.
77. HH: Handhole
78. HOA: Hand-off-automatic
79. HP or hp: Horsepower.
80. HVAC: Heating, ventilating, and air conditioning.
81. Hz: Hertz.
82. IBT: Intersystem bonding termination.
83. IC: Intercom
84. IG: Isolated ground.
85. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
86. IP: Ingress protection rating (enclosures); Internet protocol (communications).
87. IR: Infrared.
88. IS: Intrinsically safe.
89. IT&R: Inspecting, testing, and repair.
90. ITE: Information technology equipment.
91. JB: Junction Box
92. KAIC or kAIC: Kiloampere interrupting capacity.
93. kcmil or MCM: One thousand circular mils.
94. KV or kV: Kilovolt.
95. KVA or kVA: Kilovolt-ampere.
96. kVAr or kVAR: Kilovolt-ampere reactive.
97. KW or kW: Kilowatt.
98. kWh: Kilowatt-hour.
99. LAN: Local area network.
100. LT: Light
101. LTG: Lighting
102. lb: Pound (weight).
103. LCD: Liquid-crystal display.
104. LCDI: Leakage-current detector-interrupter.
105. LED: Light-emitting diode.
106. LNG: Liquefied natural gas.
107. LP-Gas: Liquefied petroleum gas.
108. LRC: Locked-rotor current.
109. MCA: Minimum circuit ampacity
110. MCB: Main circuit breaker
111. MCC: Motor-control center.
112. MDC: Modular data center.
113. MG set: Motor-generator set.
114. MH: Manhole
115. MIDI: Musical instrument digital interface.
116. MLO: Main lugs only.
117. MOCP: Maximum overcurrent protection

118. MRTS: Motor rated toggle switch
119. MSB: Main switchboard
120. MTD: Mounted
121. MTG: Mounting
122. MTS: Main transfer switch
123. MVA: Megavolt-ampere.
124. mW: Milliwatt.
125. MW: Megawatt.
126. MWh: Megawatt-hour.
127. N: Neutral
128. N.C. or NC: Normally closed.
129. NF: Non-fused
130. NiCd: Nickel cadmium.
131. NIU: Network interface unit.
132. NL: Night light.
133. N.O. or NO: Normally open.
134. NPT: National (American) standard pipe taper.
135. OCPD: Overcurrent protective device.
136. OFCI: Owner furnished contractor installed.
137. ONT: Optical network terminal.
138. P: Pole – referring to an electrical position in a panel
139. PA: Public address
140. PB: Pull box
141. PC: Personal computer.
142. PCS: Power conversion system.
143. PCU: Power-conditioning unit.
144. PF or pf: Power factor.
145. PH or ph: Phase
146. PHEV: Plug-in hybrid electric vehicle.
147. PIV: Post indicator valve.
148. PLC: Programmable logic controller.
149. PLFA: Power-limited fire alarm.
150. PoE: Power over Ethernet.
151. PV: Photovoltaic.
152. PVC: Polyvinyl chloride.
153. pW: Picowatt.
154. PWR: Power.
155. RCP: Reflected ceiling plan.
156. RECPT: Receptacle.
157. REF: Reference.
158. RFI: Radio-frequency interference (electrical); Request for interpretation (contract).
159. RMS or rms: Root-mean-square.
160. RPM or rpm: Revolutions per minute.
161. SCADA: Supervisory control and data acquisition.
162. SCCR: Short circuit current rating.
163. SCR: Silicon-controlled rectifier.
164. SD: Smoke damper.
165. SEC: Secondary.
166. SPD: Surge protective device.
167. sq.: Square.

168. SWD: Switching duty.
169. SWBD: Switchboard.
170. TBB: Telecommunications bonding backbone.
171. TC: Time clock.
172. TCP/IP: Transmission control protocol/Internet protocol.
173. TEFC: Totally enclosed fan-cooled.
174. TGB: Telecommunications grounding busbar.
175. TMGB: Telecommunications main grounding busbar.
176. TO: Telecommunications outlet.
177. TR: Telecommunications room.
178. TR: Tamper resistant.
179. TS: Tamper switch.
180. TV: Television.
181. TVSS: Transient voltage surge suppressor.
182. UG : Underground.
183. UL: Underwriters Laboratories, Inc. (standards) or UL LLC (services).
184. UL CCN: UL Category Control Number.
185. UPS: Uninterruptible power supply.
186. USB: Universal serial bus.
187. UV: Ultraviolet.
188. V: Volt, unit of electromotive force.
189. Vac or V(ac): Volt, alternating current.
190. Vdc or V(dc): Volt, direct current.
191. VA: Volt-ampere, unit of complex electrical power.
192. VAR or VAr: Volt-ampere reactive, unit of reactive electrical power.
193. VFC: Variable-frequency controller.
194. VFD: Variable-frequency drive.
195. VOM: Volt-ohm-multimeter.
196. VPN: Virtual private network.
197. VRLA: Valve-regulated lead acid.
198. W: Watt, unit of real electrical power or Wire.
199. WG: Wire guard.
200. Wh: Watt-hour, unit of electrical energy usage.
201. WP: Weather proof.
202. WPT: Wireless power transfer.
203. WPTE: Wireless power transfer equipment.
204. WR: Weather resistant.
205. XFMR: Transformer.

1.4 DEFINITIONS

A. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

B. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

C. "Provide": Furnish and install, complete and ready for the intended use.

1.5 ACTION SUBMITTALS

A. Product Data: For Fire Rated Sleeves for cables.

1.6 COORDINATION

A. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 26, Electrical Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittal.

B. Location of electrical outlets and equipment:

1. Location of electrical outlets and equipment shown on electrical drawings are diagrammatic. Unless indicated otherwise do not use electrical drawings to locate electrical outlets and equipment.
2. Luminaires and outlets:

a. Ceiling mounted luminaires and outlets: use architectural reflected ceiling plans and details to determine location unless indicated otherwise.
b. Wall mounted luminaires and outlets:

1) Use architectural elevation and section drawings to determine location unless indicated otherwise.
2) Where architectural elevation and section drawings do not indicate location of wall outlets then locate the outlet within 12 inches of location shown on electrical drawings considering field conditions.
3) Coordinate location with consideration of owner provided equipment such as wall mounted televisions, white boards, furniture, cabinets and the like.

c. Floor mounted outlets: use architectural drawings to determine location unless indicated otherwise. If not clearly indicated, then send request for information to Architect.
d. Cabinet mounted luminaires and outlets: use cabinet details and shop drawings to determine location unless indicated otherwise.
e. Exterior luminaire poles and bollards: use locations indicated on civil plans and landscape plans unless indicated otherwise
f. Landscape luminaires: use locations indicated on landscape drawings unless indicated otherwise.

3. Electrical equipment: Utilize approved manufacturer’s shop drawing dimensions to determine location of equipment in space. Comply with NEC 110.26 access, working space and dedicated equipment space requirements. Maintain manufacturer requirements for maintenance access.
4. Electrical handholes and manholes: use location shown on civil plans unless indicated otherwise.
5. Outdoor Electrical equipment: use location shown on civil plans unless indicated otherwise.

C. Shop Drawings: Provide coordinated shop drawings which include physical characteristics of all systems, device layout plans, and control wiring diagrams. Reference individual Division 26, Electrical specification sections for additional requirements for shop drawings outside of these requirements.

D. Electrical connections to equipment supplied by owner or other trades:

1. Prior to procurement of electrical equipment and field work coordinate with shop drawings and/or manufacturer's installation instructions the actual electrical characteristics of the equipment to be connected.
2. Notify engineer of significant deviations or conflicts between the shop drawings and/or the manufacturer's installation instructions and information in the contract documents.

E. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope so connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

F. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

G. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section 083113 "Access Doors and Frames."

H. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section 078413 "Penetration Firestopping."

I. Coordinate and install wiring for appliances and systems furnished under other specification Divisions or furnished by the Owner. Install electrical wiring in accordance with manufacturer's instructions.:

1. Motorized door operators.
2. Kitchen equipment including walk-in freezer and coolers.
3. Electric water coolers.
4. Exterior signage.
5. Owner provided equipment

1.7 PERMITS AND FEES

A. Owner will pay all charges and/or fees levied by the serving utility companies relative to this project.

B. Obtain and pay all fees for permits, licensing, and inspections applicable to work of Division 26, 27 and 28

1.8 QUALITY ASSURANCE

A. Regulatory Requirements: Install work and materials to conform with local, State and Federal codes, and other applicable laws and regulations.

B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturer's equipment. Drawings are not intended to show every item in its exact location, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e. distribution equipment, duct banks, light fixtures, etc.) and equipment proposed to assure that systems and equipment will ft in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.

C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.

D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Provide Qualified Personnel that are thoroughly knowledgeable of applicable codes related to electrical systems to perform the electrical work. Installations shall be performed by skilled electrical tradesmen fully aware of the latest techniques, practices, and standards of the industry. Refer to N.E.C. Article 100-Definitions, Qualified Person.

F. Install electrical equipment and components in a neat and workmanlike manner in accordance with recognized practices and industry standards. Refer to N.E.C.110-12. Haphazard or poor installation practice will be cause for rejection of the work.

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

A. Substitution requests for electrical equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration if accompanied by value analysis data indicating that substitution will comply with Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Substitution requests may be submitted for consideration concurrently with submission of power system study reports when those reports indicate that substitution is necessary for safety of maintenance personnel and facility occupants.

3. Contractor is responsible for sequencing and scheduling power system studies and electrical equipment procurement. Insufficient lead time for electrical equipment delivery will not be considered a valid reason for substitution.

2.2 SLEEVES FOR RACEWAYS AND CABLES

A. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

C. EMT: Electrical Metallic Tubing.

D. PVC: Schedule 40 or 80.

2.3 FIRE RATED SLEEVES FOR CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M
2. Hilti
3. Specified Technologies, Inc (STI)
4. Wiremold.

B. Factory assembled rectangular steel pathway containing an intumescent insert material that adjusts automatically to cable addition or subtraction.

C. Sleeve shall have an F Rating equal to or greater than the rating of the wall in which the sleeve is installed.

D. Sleeve shall be UL listed and bear the UL Classification marking.

E. Sleeve shall be tested in accordance with ASTM E814 (ANSI/UL1479).

F. Provide square wall plate kits for single sleeve applications. Provide multi-gang wall/floor plate kits for ganged applications.

G. Subject to compatibility with requirements and field conditions, i.e. sleeve size, wall thickness, etc., acceptable products include the following:

1. 3M Fire Barrier Pass-Through Devices

2. Hilti Speed Sleeves
3. Specified Technologies Inc. EZ-Path Fire Rated Pathway (series 33).
4. Wiremold Flamestopper FS4 Series

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 26. Consult Architect for resolution of conflicting requirements.

B. Comply with NECA 1.

C. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

D. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

E. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

F. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete, masonry and gypsum board walls, or fire-rated floor and wall assemblies.

B. Sleeves are required where cables (not in raceway) penetrate walls or floors. Sleeves are not required where raceways penetrate walls, except where raceways penetrate exterior walls/foundations below grade.

C. Concrete Slabs and Walls: Install sleeves during erection of slabs and walls.

D. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Provide insulated bushings on EMT sleeves for cable not in conduit. Bushings shall be plenum rated where installed in a plenum.

G. Extend sleeves installed in floors 4 inches above finished floor level unless noted otherwise.

H. Size pipe sleeves to provide 1/4-inchannular clear space between sleeve and raceway or cable, unless indicated otherwise.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section 079200 "Joint Sealants."

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section 078413 "Penetration Firestopping."

L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe or PVC, schedule 40 or 80, sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve. Cut sleeves to length for mounting flush with both surfaces of walls.

M. Fire Rated Sleeves for cables: Fabricate openings in wall or floor assemblies per manufacturer’s recommendations.

3.3 SLEEVE APPLICATION

A. Sleeves for cables not in conduit:

1. Through Non-Rated Interior Walls: EMT sleeves.
2. Through Non-Rated Floors: EMT sleeves.
3. Through Fire Rated Interior Walls: Fire Rated Sleeves for cables.
4. Through Fire Rated Floors: Fire Rated Sleeves for cables.

B. Sleeves for conduits:

1. Through Exterior Walls Below Grade: Refer to details on structural Drawings. Absent any such details provide cast iron pipe or PVC, Schedule 40 or 80, sleeve two trade sizes larger than the conduit.

C. Sleeves for Cable Trays:

1. Through Non-Rated Interior Walls: Rectangular galvanized sheet metal opening.
2. Through Fire Rated Walls: Stop cable tray 6 inches maximum for each side of wall and provide multiple fire rated sleeves for cables with combined allowable area for cable equal to the capacity of the cable tray unless noted otherwise.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section 078413 "Penetration Firestopping."

END OF SECTION 260500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Copper and aluminum building wire rated 600 V or less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Connectors, splices, and terminations rated 600 V or less.

B. Related Requirements:

1. Section 260533 “Raceway and Boxes for Electrical Systems” for allowable applications of raceways and cable assemblies. Cable assemblies, such as Type MC cable, shall not be permitted unless noted otherwise.
2. Section 260553 “Identification for Electrical Systems” for conductor color coding.

1.3 DEFINITIONS

A. PV: Photovoltaic.

B. RoHS: Restriction of Hazardous Substances.

C. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 BUILDING WIRE

A. Cooper Building Wire

1.
2. Description: Flexible, insulated and uninsulated, drawn copper or aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
3. Conductors: complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

D. Temperature Ratings: All conductors shall be rated 90-degree C minimum.

2.2 ALUMINUM BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Aluminum, complying with ASTM B800 and ASTM B801.

D. Conductor Insulation:

1. Type THHN and Type THWN-2. Comply with UL 83.
2. Type XHHW-2. Comply with UL 44.

2.3 NONMETALLIC UNDERGROUND CONDUIT WITH CONDUCTORS, TYPE NUCC

A. Description: A factory assembly of conductors or cables inside a nonmetallic, smooth wall raceway with a circular cross section.

B. Applicable Standards:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:

a. Reference Standards: UL 1990.

2.4 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.

C. Circuits:

1. Single circuit and multi-circuit with color-coded conductors. Separate neutral conductors shall be included for each circuit originating from a unique overcurrent protection device.

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Ground Conductor: Insulated.

F. Conductor Insulation:

1. Type THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

G. Armor: Steel or Aluminum, interlocked.

H. Jacket: PVC applied over armor.

2.5 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc diecast with set screws, designed to connect conductors specified in this Section.

C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Lugs for attachment to telecommunications systems grounding busbars shall be two-hole with long barrels and irreversible crimp terminations.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Feeders to Distribution Equipment and Panelboards: Type XHHW-2, single conductors in raceway.

B. NEC does not require derating of XHHW-2 due to high ambient temps.

C. Exterior Feeders and branch circuits routed horizontally on roofs: Type XHHW-2, single conductors in raceway.

D. Other Feeders and Branch Circuits: Type THHN-THWN, single conductors in raceway.

E. Feeders connected from the load-side of VFDs to electric motors: Type XHHW-2 single conductors installed in a raceway or Type XHHW-2 MC cable where permitted.

F. Conductors serving circuits downstream of a device with GFCI or GFP protection shall have XHHW-2 insulation.

G. Metal Clad Cable

1. Uses permitted:

a. Branch circuits rated less than 50 amps.
b. In areas that have accessible ceiling space.

2. Uses not permitted:

a. Feeders
b. Homeruns that are more than 50 feet of cable length from device to panel.
c. Areas where there is no access to the ceiling space.
d. Areas that have no ceiling or exposed structure.
e. Exposed.
f. Wet or damp areas.

3.3 CONDUCTOR SIZES

A. Minimum Wire Size (Interior Work): No. 12 AWG, except No. 14 AWG shall be permitted for signal, pilot control circuits and fixture whips.

B. Minimum Wire Size (Exterior Work): No 10 AWG.

C. Use #10 AWG minimum conductor size in lieu of #12 AWG minimum for 20 ampere, 120 volt branch circuits where homeruns are longer than 75 feet and for 20 ampere, 277 volt branch circuits where homeruns are longer than 175 feet. Increase in size as required for a maximum of 3 percent voltage drop from panel to load.

D. Derate conductors based on quantity of current carrying conductors in each conduit. Refer to the NEC for derating factors.

E. Derate conductors for high ambient temperatures. Refer to the NEC for derating factors.

3.4 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Branch circuits serving receptacles and lighting loads shall have dedicated neutral conductors and shall not share a common neutral conductor. The use of handle ties across single pole circuit breakers to allow the use of a common neutral is not acceptable.

H. Multiwire Branch Circuits and Shared Neutrals:

1. Multiwire branch circuits (as defined by the NEC) and shared neutrals (common grounded conductors) are not permitted, except as follows:

a. Wherever a multiwire branch circuit is specifically indicated on the Drawings and a multi-pole breaker is provided in the panel from which it originates as a means to simultaneously disconnect all ungrounded conductors.

2. Derating factors shall be applied, per NEC Article 310, to multiple current-carrying conductors installed within the same conduit. Neutral conductors shall be regarded as current-carrying conductors. Wire sizes shall be increased as needed to maintain the ampacity that corresponds to the overcurrent protection device rating.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepared test reports.

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors 100 amps and larger for compliance with requirements:

3. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    b. Test bolted connections for high resistance using one of the following:

        1) A low-resistance ohmmeter.
        2) Calibrated torque wrench.
        3) Thermographic survey.

    c. Inspect compression-applied connectors for correct cable match and indentation.
    d. Inspect for correct identification.
    e. Inspect cable jacket and condition.
    f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
    g. Continuity test on each conductor and cable.
    h. Uniform resistance of parallel conductors.

4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

    a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Photographic evidence of underground electrode(s) installation.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 ELECTRICAL GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chatsworth.
2. Cooper B-Line.
3. Erico.
4. Harger.

B. Products shall be UL listed.

C. Copper busbar, 0.25-inch-thick minimum, insulated stand-offs, factory predrilled standard size holes.

D. Electrical Grounding Busbars: Height shall be 4-inches minimum, and length shall be 24-inches minimum unless indicated otherwise on Drawings.

E. Connector Lugs: Lugs for connecting to grounding electrode conductors and bonding conductors shall be UL listed two-hole, long barrel, electro tinplated compression lugs.

2.3 TELECOMMUNICATIONS GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line
2. Chatsworth
3. Erico.
4. Harger
5. Legrand Ortronics
6. Panduit

B. Products shall be UL listed meet the specification of TIA/EIA 607 and conform to BICSI recommendations.

C. Copper busbar, 0.25-inch-thick minimum, insulated stand-offs, factory predrilled standard size holes per TIA/EIA 607 standard.

D. Telecommunications Main Grounding Busbars: Height shall be 4-inches. Length shall be 20-inches minimum unless indicated otherwise on Drawings. Chatsworth 40153 series or equal.

E. Telecommunications Grounding Busbars: Height shall be 2-inches. Length shall be 10-inches minimum unless indicated otherwise on Drawings. Chatsworth 13622 series or equal.

F. Connector Lugs: Lugs for connecting to telecommunications grounding busbars shall be UL listed two-hole, long barrel, electro tinplated compression lugs.

2.4 CONDUCTORS

A. Insulated Conductors: tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.5 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

G. Conduit Hubs: Mechanical type, terminal with threaded hub.

H. Water Pipe Clamps:

1. Mechanical type, two pieces with zinc-plated bolts.

   a. Material: Tin-plated aluminum.
   b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.6 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 30 inches below grade.

C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Provide grounding as required by the serving utility company. Grounding shall be provided at, but not limited to, the following locations:

1. Transformer
2. Meter

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.6 TELECOMMUNICATIONS GROUNDING

A. Provide grounding in accordance with TIA 607 and as indicated on the Drawings.

3.7 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

F. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

G. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.8 FIELD QUALITY CONTROL

A. Prior to covering underground UFER grounds and connections to ground rods, take digital photographs of the grounding electrodes including conductor connections. Record locations of each photograph. Submit to A/E for documentation purposes.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Report measured ground resistances.

G. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.

B. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M – Structural Welding Code - Steel.
2. AWS D1.2/D1.2M – Structural Welding Code - Aluminum.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Galvanized steel.
3. Channel Width: Selected for applicable load criteria.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA 101
3. NECA 105.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

F. Damp or wet locations: Utilize hot dipped galvanized steel slotted support systems. Apply galvanizing-repair paint to comply with ASTM A780 on cut edges.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC and RMC may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts. Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69. Spring-tension clamps.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 4500-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Boxes, enclosures, and cabinets.
4. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
2. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

C. LFMC: Liquid tight flexible metal conduit.

D. LFNC: Liquid tight flexible nonmetallic conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. GRC: Comply with ANSI C80.1 and UL 6.
3. IMC: Comply with ANSI C80.6 and UL 1242.
4. EMT: Comply with ANSI C80.3 and UL 797.
5. FMC: Comply with UL 1; zinc-coated steel.
6. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. Comply with NEMA FB 1 and UL 514B.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Fittings, General: Listed and labeled for type of conduit, location, and use.
4. Fittings for EMT:

    a. Material: Steel.
    b. Type: compression.

5. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

1. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
3. Rigid HDPE: Comply with UL 651A.
4. Continuous HDPE: Comply with UL 651B.

B. Nonmetallic Fittings:

1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
3. Below Grade Long Radius Elbows:

    a. Conduits 2 inches to 2.5 inches: use minimum 24-inch radius, Fiberglass Elbow.
    b. Conduits larger than 2.5 inches: use minimum 36-inch radius Fiberglass Elbow.

4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Metal Floor Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Hubbell
    b. ABB
    c. Legrand/Wiremold
    d. Steel City
    e. FSR

2. Material: sheet metal.
3. Type: Fully adjustable.
4. Shape: Rectangular.
5. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Multi-Compartment Floor Boxes up to 6 gangs:

a. Provide multi-service shallow stamped steel recessed floor box, fully adjustable with feed-through tunneling to adjacent compartments.
b. Duplex receptacles: provide as indicated on the drawings.
c. Telecom jacks: provide as indicated on the drawings.
d. Audio Visual connectors: provide as indicated on the drawings.
e. Provide water resistant activation cover meeting UL scrub water exclusion requirement.
f. Basis of design Legrand/Wiremold RFB-SS series.
g. Include all accessories for a complete installation.
h. Floor Box Cover Assembly:

1) Terrazzo or finished concrete floors: Flangeless lid flush with finished floor, flat smooth surface (no inserts), die-cast aluminum with brushed aluminum finish. Legrand/Wiremold FloorPort FP Series. Lid must be installed exactly flush with the finished floor—no exceptions.
2) Carpet, tile, wood, or other floor types: Flanged lid, flat smooth surface with no inserts, die-cast aluminum with brushed aluminum finish, Legrand/Wiremold FloorPort FP Series. Flanged lid must be installed tight to floor—no exceptions.

E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep.

J. Gangable boxes are allowed.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 for indoor dry locations and Type 4 for wet and outdoor locations with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

2.4 SLEEVE AND SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM (Ethylene-propylene-diene terpolymer rubber) or NBR (Acrylonitrile-butadiene rubber) interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Plastic or carbon steel or stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

D. Grout: Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Size: minimum as required by NFPA 70 unless larger size is indicated on drawings OR as indicated on plans

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Oldcastle, Armorcast, Quazite (Hubbell), Newbasis, or approved.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, Match system (ie electric, data, telecom, fire alarm, etc.).

7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.6 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Above Grade Exposed Conduit: GRC or IMC.
2. Concealed Conduit, Aboveground: GRC or IMC.
3. Underground Conduit:

    a. Under footprint of building: RNC, Type EPC-40-PVC, direct buried, concrete encased or as indicated on the drawings.
    b. Outside of the building footprint: RNC, Type EPC-40-PVC or HDPE schedule 40.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Severe Physical Damage: EMT.
2. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. Gymnasiums.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: IMC.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size:

1. Indoor areas: 1/2-inch trade size minimum
2. Buried, below or in concrete slab: ¾-inch trade size minimum.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use compression, steel. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines. The following are exceptions for concealing conduits:

1. Where specifically noted or indicated on the drawings.
2. Electrical rooms with surface mounted panels.
3. Mechanical rooms.
4. In open ceilings with exposed structure.

K. Do not install conduits exposed to solar heat gain such as roof tops unless indicated on the drawings.

L. Support conduit within 12 inches of enclosures to which attached.

M. Raceways Embedded in Slabs:

1. Conduit embedded in concrete slabs shall be positioned within the middle third of the slab and secured with approved supports. In no case shall the outside dimension of the conduit exceed 1/3 the thickness of the slab. Conduits in slabs shall not be placed any closer than 3 conduit diameters on-center, and they shall not cross over each other.
2. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in concrete.
3. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
4. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
5. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
6. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

N. Stub-Ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

O. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal

bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

T. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

V. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

W. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces. or from conditioned spaces to non-conditioned spaces or to exterior structures.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

X. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Y. Expansion-Joint Fittings:

1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Z. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations.

AA. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

BB. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

CC. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

DD. Locate boxes so that cover or plate will not span different building finishes.

EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

GG. Set metal floor boxes level and flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified by Civil.
2. Install backfill as specified by Civil.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified by Civil.
4. Install manufactured rigid steel conduit or fiberglass elbows for stub-ups at poles and equipment, horizontal directional changes and at building entrances through floor.

    a. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel or fiberglass conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment if steel conduit is used.

5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth. Provide 12 inches depth of crushed stone or gravel under the handhole.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, 32 inches below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. Grass area: Provide 8-inch thick by 12-inch-wide concrete around handhole.

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL.

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Duct accessories.
4. Polymer concrete handholes and boxes with polymer concrete cover.

1.3 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

D. GRC: Galvanized rigid (steel) conduit.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Include accessories for handholes, boxes.
4. Include underground-line warning tape.

B. Shop Drawings:

1. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

1.6 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

B. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. Coated Steel Conduit: PVC-coated GRC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carlon
2. Cantex
3. Atkore
4. Pencell

B. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

C. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.3 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Oldcastle
2. Armorcast
3. Quazite (Hubbell),
4. Newbasis

B. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Gray.

E. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, as indicated for each service.

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches longand larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.4 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed and protect vegetation to remain according to Civil drawings. Remove and stockpile topsoil for reapplication according to Civil drawings.

3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Electrical Cables More Than 600 V: Type EPC-80-PVC RNC, direct buried unless otherwise indicated.

B. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.

C. Duct for Electrical Branch Circuits: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.

D. Duct for Fiber Optical Cabling: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.

E. Bored Underground Duct: Type EPEC-40-HDPE unless otherwise indicated.

F. Underground Ducts Crossing Driveways and Roadways: Type EPC-40 PVC RNC, encased in reinforced concrete.

G. Stub-ups and horizontal bends: Concrete-encased PVC-coated GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
5. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Civil drawings, but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area after construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Civil.

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

F. Where conduit lines are installed under grass plots, the sod shall be removed, stored at one side of the lot, and kept watered. As soon as the trench is backfilled, this sod shall be replaced. Where conduit is installed between trees, trees and roots must be protected from damage.

G. All duct banks of (3) conduits or more shall be covered with (1) sack slurry to prevent air pockets.

3.5 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Control or communications conduits associated with medium voltage ductbank runs shall not pass through manholes containing medium voltage power conductors. Provide handholes adjacent to the manholes to route the controls or communications pathway through.

D. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

E. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 36 inches, both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

F. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

G. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.

H. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 270544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

I. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

J. Pulling Cord: Install 200-lbf- test nylon cord in empty ducts.

K. Concrete-Encased Ducts and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified by Civil for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 24 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
4. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
6. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
7. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
8. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.

    a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be flush with finished floor and minimum 3 inches from conduit side to edge of slab

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be flush with finished floor and no less than 3 inches from conduit side to edge of slab

9. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
10. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

11. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
12. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

L. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application. Direct-Buried Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements by Civil for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.
4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent movement. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
8. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.
9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

    a. Couple RNC duct to GRC or fiberglass conduit with adapters designed for this purpose and encase coupling with 3 inches of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment if GRC is used.

1) Stub-ups shall be flush with finished floor and minimum 3 inches from conduit side to edge of slab

c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment if GRC is used.

1) Stub-ups shall be flush with finished floor and no less than 3 inches from conduit side to edge of slab

11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements by Civil for installation of backfill materials.

a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
b. Place minimum 6 inches of engineered fill above concrete encasement of duct.

M. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

N. Electric ductbanks shall be colored red on tops and sides.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

1. Comply with ASTM C891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below frost line, 32 inches below grade.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

5. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.

F. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line, 32 inches below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. Grass area: Provide 8-inch thick by 12-inch wide concrete around handhole.

3.8 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION 260543

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

C. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70.

B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

C. Comply with ANSI Z535.4 for safety signs and labels.

D. Comply with NFPA 70E and Section 260570 "Overcurrent Protective Studies" requirements for arc-flash warning labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
2. Colors for 208/120-V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.
d. Neutral: White

3. Colors for 480/277-V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.
d. Neutral: Gray

4. Color for Equipment Grounds: Green.

C. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

D. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

E. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Minimum Nominal Size:

a. 1-1/2 by 6 inches for raceway and conductors
b. 3-1/2 by 5 inches for equipment.
c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

2.5 TAPES AND STENCILS

A. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

B. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

C. Underground-Line Warning Tape:

1. Tape:

    a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
    b. Printing on tape shall be permanent and shall not be damaged by burial operations.
    c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:

    a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
    b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE"
    c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

3. Tag: Type I:

    a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
    b. Width: 3 inches.
    c. Thickness: 4 mils.
    d. Weight: 18.5 lb/1000 sq. ft..
    e. Tensile according to ASTM D882: 30 lbf and 2500 psi.

4. Tag: Type ID:

    a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
    b. Width: 3 inches.
    c. Overall Thickness: 5 mils.
    d. Foil Core Thickness: 0.35 mil.
    e. Weight: 28 lb/1000 sq. ft..
    f. Tensile according to ASTM D882: 70 lbf and 4600 psi.

D. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 TAGS

A. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

2.7 SIGNS

A. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:

    a. For signs up to 20 sq. in., minimum 1/16 inch thick.
    b. For signs larger than 20 sq. in., 1/8 inch thick.
    c. Engraved legend with black letters on white face.
    d. Self-adhesive.
    e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

I. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

K. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

L. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

M. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

N. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

O. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

P. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

Q. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

R. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

S. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

T. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
2. Use detectable Type ID underground warning tape at duct banks that have two or more conduits.
3. Use Type I underground warning tape at underground branch circuits and feeders.
4. Install underground-line warning tape for direct-buried cables and cables in raceways.

U. Nonmetallic Preprinted Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using cable ties.

V. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

W. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30A: Identify with self-adhesive raceway labels or vinyl tape applied in bands.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
2. Apply the following identification colors:

a. 480Y/277 Volt Distribution System: Orange.
b. 208Y/120 Volt, Distribution System: White.
c. Fire Alarm System: Red.
d. Motor and Other Control Systems: Black.
e. Clock, Sound, Intercom, Data: Blue.
f. Ground: Green.

D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.

G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.

H. Auxiliary Electrical Systems Conductor Identification: Marker tape or Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
3. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
4. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
5. Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands or snap-around color-coding bands:

    a. Fire Alarm System: Red.
    b. Mechanical and Electrical Supervisory System: Brown.
    c. Telecommunication System: Blue and yellow.
    d. Control Wiring: Orange and red.

I. Grounding Electrode Conductors and Grounding System Conductors: At each electrical room and communications room ground bus bar, label each raceway or conductor at the ground bus bar. Identify the destination of each grounding electrode conductor, bonding jumper and grounding system conductor. The labeling shall be by permanent adhesive label on the raceway. Conductors that terminate in the same room and the entire path is readily visible do not require labeling.

J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

K. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

L. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

    a. Power-transfer switches.
    b. Controls with external control power connections.

N. Arc Flash Warning Labeling: Self-adhesive labels.

O. Operating Instruction Signs: Self-adhesive labels.

P. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

Q. Equipment Identification Labels:

1. Indoor Equipment: Self-adhesive label.
2. Outdoor Equipment: Laminated acrylic or melamine sign.
3. Equipment to Be Labeled:

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
    b. Enclosures and electrical cabinets.
    c. Access doors and panels for concealed electrical items.
    d. Switchboards.
    e. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    f. Emergency system boxes and enclosures.
    g. Enclosed switches.
    h. Enclosed circuit breakers.
    i. Enclosed controllers.
    j. Variable-speed controllers.
    k. Push-button stations.
    l. Power-transfer equipment.
    m. Contactors.
    n. Remote-controlled switches, dimmer modules, and control devices.
    o. Battery-inverter units.
    p. Power-generating units.
    q. Monitoring and control equipment.
    r. UPS equipment.

END OF SECTION 260553

SECTION 260570 – OVERCURRENT PROTECTIVE DEVICE STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes a computer-based studies and analysis as follows:

1. Fault-current study to determine the minimum interrupting capacity of circuit protective devices.
2. Overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
3. Arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

B. Normal and optional stand-by system distribution devices shall be coordinated to 0.2 seconds. Emergency System devices shall be selectively coordinated per NEC Article 700.32. Legally Required Standby System devices and optional stand-by system devices shall be selectively coordinated per NEC 701.27.

1.3 DEFINITIONS

A. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

B. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

C. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

D. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

E. SCCR: Short-circuit current rating.

F. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

G. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals shall be in printed and digital form.

    a. Short-circuit study input data, including completed computer program input data sheets.
    b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

        1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
        2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

    c. Coordination-study input data, including completed computer program input data sheets.
    d. Study and equipment evaluation reports.
    e. Arc-flash study input data, including completed computer program input data sheets.
    f. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.

3. Overcurrent protective device coordination and arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

    a. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Software Developer.
2. For Power System Analysis Specialist.
3. For Field Adjusting Agency.

B. Product Certificates:

1. For short-circuit study software, certifying compliance with IEEE 399.

2. For overcurrent protective device coordination study software, certifying compliance with IEEE 399
3. For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
2. The following are from the Short-Circuit Study Report:

    a. Final one-line diagram.
    b. Final Short-Circuit Study Report.
    c. Short-circuit study data files.
    d. Power system data.
    e. Final protective device coordination study.
    f. Coordination study data files.
    g. List of all protective device settings.
    h. Time-current coordination curves.

3. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
4. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications:

1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies, coordination studies, and arc-flash analysis.
2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

F. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.

G. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. EasyPower, LLC (formerly ESA Inc.).
2. CGI CYME
3. SKM Systems Analysis, Inc.

B. Comply with IEEE 242, IEEE 399, IEEE 551, IEEE 1584 and NFPA 70E.

C. Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program shall be capable of the following:

1. Plotting and diagramming time-current-characteristic curves as part of its output.
2. Report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
3. Arcing faults.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.

6. Derating factors and environmental conditions.
7. Any revisions to electrical equipment required by the study.

D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstands ratings exceed available short-circuit current at equipment installation locations.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Calculated asymmetrical fault currents:

        1) Based on fault-point X/R ratio.
        2) Based on calculated symmetrical value multiplied by 1.6.

3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

2.3 COORDINATION STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.
6. Any revisions to electrical equipment required by the study.
7. Study Input Data: As described in "Power System Data" Article.

D. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

a. Phase and Ground Relays:

1) Device tag.
2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:

1) Adjustable pickups and time delays (long time, short time, and ground).
2) Adjustable time-current characteristic.
3) Adjustable instantaneous pickup.

4) Recommendations on improved trip systems, if applicable.

c. Fuses: Show current rating, voltage, and class.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

   a. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
   b. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
   c. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
   d. Cables and conductors damage curves.
   e. Ground-fault protective devices.
   f. Motor-starting characteristics and motor damage points.
   g. Generator short-circuit decrement curve and generator damage point.
   h. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Maintain selectivity for tripping currents caused by overloads.
6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
7. Provide adequate time margins between device characteristics such that selective operation is achieved.
8. Comments and recommendations for system improvements.

2.4 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.

3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

D. Study Input Data: As described in "Power System Data" Article.

E. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

F. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

G. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.5 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Protection boundaries.

a. Arc-flash boundary.
b. Restricted approach boundary.
c. Limited approach boundary.

4. Arc flash PPE category.
5. Required minimum arc rating of PPE in Cal/cm squared.
6. Available incident energy.
7. Working distance.
8. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled.

B. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

C. Provide necessary data required to complete the study to Power System Analysis Specialist.

3.2 POWER SYSTEM DATA

A. This article lists data needed to conduct the study. Delete data already indicated on one-line diagram; add data that should be considered in study results.

B. Obtain all data necessary for conduct of the studies.

1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.

C. See the Evaluations for data on NETA and NICET certifications.

D. Gather and tabulate the required input data to support the short-circuit study, coordination study and arc-flash study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that

is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
10. Maximum demands from service meters.
11. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
12. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
13. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
14. Motor horsepower and NEMA MG 1 code letter designation.
15. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
16. Derating factors.
17. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

I. Include in the report identification of any protective device applied outside its capacity.

3.4 COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin analysis at the service, extending down to system overcurrent protective.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

H. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

J. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.

K. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

M. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.

2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.
4. Include in the report identification of any protective device applied outside its capacity.

3.5 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.

C. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

D. Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.

E. Calculate the limited, restricted, and prohibited approach boundaries for each location.

F. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

G. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

H. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.6 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

3.7 LABELING

A. Apply one arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

B. Each piece of equipment listed below shall have an arc-flash label applied to it:

1. Low-voltage switchboard.
2. Medium voltage transformers
3. Low voltage transformers
4. Panelboard and safety switch over 250 V.
5. Applicable panelboard and safety switch under 250 V.
6. Control panel.

C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.

1. Indicate arc-flash energy.
2. Indicate protection level required.

3.8 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.9 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION 260570

SECTION 260800 - COMMISSIONING FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Owner's Project Requirements and Basis-of-Design Document are included by reference for information only.

C. ASHRAE Guideline 0 and 1.

D. Project’s Commissioning Plan: The commissioning plan is prepared by CxA and expands and makes more specific the information contained here.

1.2 SUMMARY

A. Section includes commissioning process requirements for electrical systems, assemblies, and equipment.

B. The Commissioning (Cx) process requires the active involvement of the responsible builder (General Contractor or Construction Manager) and the affected Division contractors (Subs) and assigns work and responsibilities that are specified here. (For this specification "Construction Manager" or "CM" will be used to refer to the responsible builder.)

C. Related Sections:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For construction checklists, comply with requirements in various Division 26 Sections specifying electrical systems, system components, equipment, and products.

1.3 DEFINITIONS

A. BoD: Basis-of-Design Document, as defined in Section 019113 "General Commissioning Requirements."

B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

D. Essential Power Systems: A power system that a facility transitions to in the absence of Normal power. This power includes all systems classified as "standby" or "emergency," including "legally required."

E. Low Voltage: 600 V and below.

F. Medium Voltage: 601 V and above.

G. Normal Power Systems: A power system that provides primary power to a facility.

H. OPR: Owner's Project Requirements, as defined in Section 019113 "General Commissioning Requirements."

I. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.4 COMMISSIONING

A. Section includes Cx process requirements for the following electrical systems, assemblies, and equipment:

1.
2. Interior and Exterior Lighting System Controls
3. Emergency Power Systems and Specialty Systems
4. Controlled receptacles Controls
5. Uninterruptible Power Supply (UPS)

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electrical systems and components to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Testing Technician Qualifications: Technicians to perform Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level. Vocational school four-year-program graduate or an Associate's degree in electrical systems, or similar field. Degree may be offset by three years' experience as an apprentice or a journey-level electrician. Generally, required knowledge includes electrical and HVAC&R concepts, building operations, and application and use of tools and instrumentation to measure performance of electrical equipment, assemblies, and systems.
2. Minimum three years’ experience installing, servicing, and operating systems manufactured by approved manufacturer.

1.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 260800

SECTION 260923 - LIGHTING CONTROL SYSTEMS AND DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Digital lighting management systems.
2. Daylight-harvesting controls and photoelectric sensors.
3. Indoor occupancy and vacancy sensors.
4. Switchbox-mounted occupancy sensors.
5. Lighting contactors.
6. Conductors and cables.

1.2 SUBMITTALS

A. Product Data and Shop Drawings:

1. Submit manufacturer's technical product data for each type of lighting control system and its components.
2. Manufacturer's warranty documentation specifically for this contract.
3. Floor plans and reflected ceiling plans showing occupancy and daylight-harvesting photoelectric sensor locations.
4. Include typical mounting details for each sensor type.
5. Detailed point to point wiring diagrams.
6. Wiring schedules.
7. Typical wiring diagrams for each component.

B. Closeout Documentation:

1. Field quality-control test reports.
2. Record drawings reflecting as-built information, including floor plans, wiring diagrams, equipment and wiring schedules, and room schedules.
3. Operation and Maintenance Manuals:

    a. Manufacturer's technical product data and maintenance data.
    b. Manufacturer's warranty documentation.

4. Software and Firmware Operational Documentation:

    a. Software service agreement.
    b. Software operating and upgrade manuals.

1.3 WARRANTY

A. Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, software, and devices that fail to perform as specified within extended warranty period.

1. Special Extended Warranty Period: Shall exceed four (4) years starting from the first date of business (FDOB).

a. If the manufacturer's warranty commences upon the date materials are delivered, then the manufacturer's warranty period shall be at least five (5) years to meet the requirement stated above.

1.4 SOFTWARE AND FIRMWARE SERVICE AGREEMENT

A. Technical Support: Beginning at the first day of business (FDOB) provide a 5-year software service agreement to the Owner.

B. Software and Firmware Upgrades:

1. The first day of business, update software and firmware to latest version. Install and program software upgrades that become available within two years from the first day of business. Verify upgrading software includes operating system and new or revised licenses for using software.
2. Upgrade Notice: Provide a 30-day notice to Owner to allow scheduling and access to the system and to allow Owner upgrade to computer equipment if necessary.
3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

1.5 QUALITY ASSURANCE

A. Codes and Standards:

1. NFPA 70, National Electrical Code (NEC).
2. UL 508, Standard for Industrial Control Panels.
3. UL 916, Standard for Energy Management Equipment.
4. UL 917, Standard for Clock Operated Switches.
5. UL 924, Standard for Emergency Lighting and Power Equipment.
6. 47 CFR, Subparts A and B, for Class A digital devices.

B. Comply with NEC, NEMA, and FCC emission requirements for Class A applications. Comply with applicable city, county, and state codes and ordinances.

C. Certification: Manufacturer shall certify that products will meet product specifications and local energy codes. If any additional equipment is required to meet coverage patterns and local energy codes, provide additional equipment at no additional cost to the Owner.

D. Selection, quantity, and placement of all lighting control sensors as indicated on the drawings shall be regarded as the basis of design. Under this contract, engage a factory-authorized representative to determine optimal selection, quantity, and placement of sensors and other system components using the manufacturer's actual devices, and to guarantee the proper application and correct operation of such devices. Any deviation from the basis of design still must comply with these specifications and must result in function and performance that meets or exceeds that of the basis of design.

E. Manufacturer's Field Service and Commissioning: Engage a factory-authorized service representative to inspect, test, and adjust sensors and associated system components, and to guarantee sensor performance.

F. Ceiling-mount devices and wall-mount devices installed above 6 ft. shall be flat and/or textured white. Wall-mount devices installed 42-inch above floor shall match device color and wall plate specified in Section 262726 "Wiring Devices".

PART 2 - PRODUCTS

2.1 DIGITAL LIGHTING MANAGEMENT SYSTEMS

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acuity Brands, Inc. (nLight / Sensor Switch).
2. Crestron Electronics, Inc. (Green Light).
3. Eaton / Greengate / Cooper Lighting Controls, Inc.
4. Encelium / Osram Sylvania, Inc.
5. Hubbell Building Automation / Lighting Controls (NX Distributed Intelligence).
6. Intelligent Lighting Controls, Inc.
7. Leviton Manufacturing Co.
8. Watt Stopper/Legrand Vantage Controls/Digital Lighting Management.

C. System Description and Operation

1. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photoelectric sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible to minimize overall device count of system.
2. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher-level network backbone.
3. Lighting control zone shall be capable of automatically configuring itself for default operation without any startup labor required.

4. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.
5. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.
6. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e., not in remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.
7. System shall have a primary wall mounted network control “gateway” device capable of accessing and controlling connected system devices and linking into an Ethernet LAN.
8. System shall use “bridge” devices that route communication and distribute power for up to 8 lighting zones together for purposes of decreasing system wiring requirements.
9. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.
10. Individual lighting zones shall be capable of being segmented into several channels of occupancy, photoelectric sensor, and switch functionality for more advanced configurations and sequences of operation.
11. System shall be capable of operating a lighting control zone according to several sequences of operation. Note operating modes should be utilized only in manners consistent with local energy codes.

    a. Auto-on / auto-off (via occupancy sensors)
    b. Manual-on / auto-off
    c. Auto-to-override on
    d. Manual-to-override on
    e. Auto on /predictive off
    f. Multi-level on (multiple lighting levels per manual button press)

12. System programming shall be done in the following fashion:

    a. For completely networked systems, system programming and control adjustments can be done via software from a single point in the network.
    b. For stand-alone systems, programming shall be done by hand-held remote control or by software app via standard wireless protocol such as Wi-Fi or Bluetooth.

13. Control software shall enable integration with a BAS via BACNET IP.

D. System Cabling: Intelligent devices shall be connected to the LRC (lighting room controller). Communications and Class 2 low voltage power shall be provided to each intelligent device via standard low-voltage UTP Category 5 cabling with RJ45 connectors. RJ45 adapters may be used to allow standard analog sensors to be used.

1. All cabling for intra-room connectivity of control devices (example, between power packs and from power packs to sensors and switches) shall be pre-manufactured and provided by controls manufacturer.
2. Intelligent lighting control devices shall communicate digitally and possesses at least two RJ45 connectors.

3. Devices within a lighting control zone shall be connected using low-voltage cabling, in a daisy-chain fashion, and in any order.
4. System shall provide the option of having pre-terminated plenum rated Category 5 cabling supplied with hardware.

E. Management Software

1. Every device parameter (e.g., sensor time delay and photoelectric sensor set point) shall be available and configurable remotely from the software.
2. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current occupancy sensor status, remaining occupancy time delay(s), current photoelectric sensor reading, current photoelectric sensor inhibiting state, photoelectric sensor transitions time remaining, current dim level, device temperature, and device relay state(s).
3. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom labels, and parent network device.
4. A printable network inventory report shall be available via the software.
5. A printable report detailing all system profiles shall be available via the software.
6. Software shall require all users to login with a username and password.
7. Software shall provide at least three permission levels for users.
8. All sensitive stored information and privileged communication by the software shall be encrypted.
9. All device firmware and system software updates must be available for automatic download and installation via the internet.
10. Software shall be capable of managing systems interconnected via a WAN (wide area network).

F. Applications:

1. Furnish and install digital lighting management systems in each room, space, or area as indicated on the Drawings, or wherever the following applies:

    a. Wherever lighting is controlled by a low-voltage multi-button control station (as opposed to a line-voltage switch).
    b. Wherever the Energy Code requires the lighting to be turned on via manual operation only and/or a room where the lighting is controlled by one or more vacancy sensors.

G. Intelligent Lighting Room Controller (LRC)

1. The LRC associated with each Digital Lighting Management System is not necessarily shown on the plans.

    a. Each controller shall be mounted above the accessible ceiling, unless otherwise noted. Where there are no suspended ceilings, mount controller above nearest accessible ceiling or near the associated power panelboard. The contractor shall be responsible for determining the optimum locations in the field.
    b. Controllers mounted above accessible ceilings shall be furnished with a plenum-rated enclosure. If ceiling is not accessible, provide an access panel in the ceiling

or coordinate with the Owner an acceptable location for a surface-mounted enclosure.

2. System shall be true digital control with digital sensors and other components. Hybrid analog systems are not acceptable.
3. The installation of software shall not be required. At a minimum, the user interface shall provide the following functions:

    a. Automatic discovery of system devices.
    b. Commissioning of devices into logical control zones and areas.
    c. Display the entire system in a logical navigation tree view.
    d. Allow the user to name zones, groups, presets, schedules, and individual loads.
    e. Setup control functions for system inputs and outputs.
    f. Monitor status and override individual relays and dimmers.

4. Programming shall be stored in non-volatile memory, so that all field-settings and programming are retained in the event of a power outage.
5. Unit power supply shall be dual-rated or rated to match its branch lighting circuit connection of 120-volt or 277-volt AC as indicated on the plans.
6. Each LRC that is required in a space shall be capable of accommodating and controlling at least two (2) line-voltage lighting circuits. Provide additional units as required for application indicated on the Lighting Plans and/or Schedules.
7. Unit must be capable of providing 0-10 VDC 200 mA dimming controls for each zone (or “switchleg”) of LED dimmable drivers. Dimmer interface shall be achieved via lighting control stations with programmable pushbuttons. Applications, zones, and quantities shall be determined per the drawings.
8. Unit must interface with presence sensors that are designated as vacancy sensors to enable lights to be turned on only manually—not automatically unless the lights had timed-out within the previous 30 seconds.
9. Integral surge protection: Meets ANSI/IEEE Standard C62.41-1980, tested to withstand momentary voltage surges up to 6000V and current surges up to 200A without damage.
10. Furnish and install a completely functioning turnkey system. Include all necessary accessories, programming, settings, commissioning, and testing.
11. Communications and Class 2 low-voltage power connection between LRC and input devices (control stations, sensors, etc.) shall be standard low-voltage UTP Category 5 cabling with RJ45 connectors.

H. Low-Voltage Momentary-Contact Programmable Pushbutton Lighting Control Stations

1. Provide programmable 1-, 2-, 3-, 4-, 5-, 6-. 7-, or 8-button control stations corresponding to each application indicated on the lighting plans and lighting control diagrams, including power enable/disable and dimming controls. “Buttons” may also be provided via an optional touchscreen interface device.
2. Include an LED status indictor integral to each programmable button or a touchscreen status indicator.
3. Include factory-produced symbols etched into each programmable button to indicate its general function, such as on/off, up, down (dimming), etc. Refer to details on the drawings. If an optional touchscreen interface device is provided, labeling and symbols may be programmed on the display.

4. Multiple control stations located within the same vicinity shall be mounted in a common wall-box with a multi-gang faceplate.
5. Initial Programming: Upon energizing luminaires, each control station shall be programmed to provide basic manual on/off functions (so that no luminaire remains on or off 24/7 without manual control). This initial programming shall be provided prior to the manufacturer's factory-authorized technician performing their official system programming, configuration, startup, and system commissioning services.
6. Communications and Class 2 low-voltage power connection between device and LRC shall be standard low-voltage UTP Category 5 cabling with RJ45 connectors.

I. Presence Sensors (Indoor Occupancy and Vacancy Sensors)

1. Refer to indoor occupancy/vacancy sensors below for types and performance specifications.

    a. Auxiliary Contacts: Provide each zone of lighting control with an additional auxiliary contact/relay, form C, dry contacts, rated for and compatible with the building automation system (BAS). Contact may be provided integral to either the presence sensor or the LRC. Coordinate with the Division 23 contractor.

2. Presence sensors shall function as vacancy sensors by default, which requires the occupant to manually turn on the lights.

    a. Typical exceptions, unless noted otherwise: Toilet rooms, restrooms, locker rooms, and other special locations as indicated on the drawings.

3. Communications and Class 2 low-voltage power connection between device and LRC shall be standard low-voltage UTP Category 5 cabling with RJ45 connectors.

J. Photoelectric Sensors (Digital Daylight-Harvesting Dimming Controls)

1. Refer to Daylight-Harvesting Dimming Controls (Digital) below for types and performance specifications.
2. Device shall be provided in conjunction with a dimming daylighting system capable of being programmed and calibrated to maintain the lighting design level in the room served.
3. The daylight sensor shall provide ambient light level information to the LRC allowing daylight responsive lighting control.
4. Communications and Class 2 low-voltage power connection between device and LRC shall be standard low-voltage UTP Category 5 cabling with RJ45 connectors.

2.2 PROGRAMMABLE ELECTRONIC ASTRONOMIC TIME CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grasslin Controls Corporation; a GE Industrial Systems Company.
2. Intermatic, Inc.
3. Leviton Mfg. Company, Inc.

4. Lightolier Controls; a Genlyte Company.
5. Lithonia Lighting; Acuity Lighting Group, Inc.
6. Paragon Electric Co.; Invensys Climate Controls.
7. Square D; Schneider Electric.
8. TORK.

B. Electronic, solid state, programmable, with alphanumeric display; astronomic time feature, complying with UL 917.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Programming Capabilities: Each channel/contact shall be individually programmable with 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
3. Programmable Channels/Contacts: Refer to Drawings for quantities necessary to control zones of lighting that require time control. Provide one additional unused spare channel for future.
4. Astronomic Time: Provide for all channels to enable geographically specific time-of-day adjustments corresponding to dusk and dawn.
5. Contact Configuration: DPDT.
6. Contact Rating: 20A 120/277 V(ac).
7. Programs:

    a. Four (4) on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
    b. Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
    c. Four (4) channels; each channel is individually programmable with eight on-off set points on a 24-hour schedule.
    d. Two (2) channels; each channel is individually programmable with two on-off set points on a 24-hour schedule with a skip-a-day weekly schedule.

8. Astronomic Time: All channels.
9. Automatic daylight savings time changeover.
10. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.
11. Unit Operating Voltage: 120 V(ac) or 277 V(ac), whichever voltage is most readily available. Refer to the drawings. Provide power connection to nearest available panel and branch circuit.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, FLEXIBLE MOUNTING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. Grasslin Controls Corporation; a GE Industrial Systems Company.
2. Intermatic, Inc.
3. Leviton.

4. Novitas, Inc.
5. Paragon Electric Co.; Invensys Climate Controls.
6. Square D; Schneider Electric.
7. TORK.

B. Description: Solid state, with SPST dry contacts to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range. As needed, provide a directional lens in front of the photoelectric sensor to prevent fixed light sources from causing turn-off.
3. Time Delay: Fifteen-second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
6. Failure Mode: Luminaire stays ON.

2.4 STEPPED DAYLIGHTING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. Cooper Lighting Controls, Inc./Greengate
2. Crestron Electronics, Inc.
3. Grasslin Controls Corporation; a GE Industrial Systems Company.
4. Hubbell Building Automation.
5. Intelligent Lighting Controls, Inc.
6. Intermatic, Inc.
7. Legrand / Watt Stopper
8. Leviton.
9. Lithonia Lighting; Acuity Lighting Group, Inc.
10. Paragon Electric Co.; Invensys Climate Controls.
11. TORK.

B. Description: System operates indoor lighting.

C. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.

1. Lighting control set point is based on two lighting conditions:

a. When no daylight is present.
b. When significant daylight is present (target level).
c. System programming is done with two hand-held, remote-control tools.

D. Ceiling-Mounted Switching Controls:

1. Solid-state, light-level sensor unit, with power pack, that detects changes in indoor lighting levels that are perceived by the eye.
2. Solid-state, light-level sensor unit, with separate power pack, that detects changes in indoor lighting levels that are perceived by the eye.
3. Programming shall be stored in non-volatile memory, so that all field-settings and programming are retained in the event of a power outage.

E. Electrical Components, Devices, and Accessories:

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Sensor Output:

    a. Contacts rated to operate the associated power pack, complying with UL 773A. Sensor must be powered by the power pack.
    b. Digital signal compatible with power pack.

4. Sensor type: Open loop.
5. Zone: Single.
6. Power Pack:

    a. Dry contacts rated for 20 A LED load at 120- and 277 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.

        1) LED status lights to indicate load status.
        2) Plenum rated.

7. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
8. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc, with an adjustment for turn-on and turn-off levels within that range.
9. Skylight Sensors Light-Level Monitoring Range: 1000 to 10 000 fc, with an adjustment for turn-on and turn-off levels within that range.
10. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
11. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
12. Test Mode: User selectable, overriding programmed time delay to allow settings check.
13. Control Load Status: User selectable to confirm that load wiring is correct.
14. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.5 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

A. Manufacturers: Match same manufacturer provided for Digital Lighting Management system above.

B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.

1. The system shall operate in an open or closed loop sequence of operation reducing the amount of electric light as the quantity of daylight entering the room increases.
2. It shall be possible to configure multiple daylight zones in a room with open loop sensors. Each zone shall be programmable to proportionally respond to the light level provided by the daylight sensor.
3. Lighting control set point is based on the following two lighting conditions:

    a. When no daylight is present (target level).
    b. When significant daylight is present (exceeding target level).

4. System programming is done with two hand-held, remote-control tools.

    a. Initial setup tool.
    b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

5. Programming shall be stored in non-volatile memory, so that all field-settings and programming are retained in the event of a power outage.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate power-pack, to detect changes in indoor lighting levels that are perceived by the eye.

1. If photoelectric sensor is associated with a digital lighting management system, in which case the LRC (lighting room controller) shall function as the power-pack.
2. Sensor shall be mounted and positioned to provide an unobstructed view of the windows per the manufacturer's directions.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Sensor Output: zero to 10 V(dc) to operate luminaires. Sensor is powered by controller unit.
3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

E. Power Pack (if not integral to LRC): Digital controller capable of accepting three 8PSJ inputs with one output rated for 20 A LED load at 120 and 277 V(ac). Sensor has 24 V(dc) Class 2 power source.

2.6 INDOOR OCCUPANCY AND VACANCY SENSORS

A. Manufacturers: Match same manufacturer provided for Digital Lighting Management system above.

B. General Requirements for all Presence Sensors:

1. Wall- or ceiling-mounted, solid-state indoor occupancy and vacancy sensors, as indicated on the drawings, designed to detect the presence of human activity within the desired space and to control the on/off function of the luminaires within that space.
2. Passive-infrared, ultrasonic or dual-technology as indicated on the drawings.
3. Separate power pack.

    a. If sensor is associated with a digital lighting management system, in which case the LRC (lighting room controller) shall function as the power pack.

4. Hardwired connection to switch or multi-button control station.
5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
6. Sensors shall be able to function together with other sensors to provide expanded coverage areas by simply daisy-chaining together each device with low-voltage communications cabling.
7. Operation:

    a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time-delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time-delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time-delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    d. Programming shall be stored in non-volatile memory, so that all field-settings and programming are retained in the event of a power outage.

8. Power Pack (if not integral to LRC): Dry contacts rated for 20 A LED load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
9. Mounting:

    a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
    b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

10. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
11. Auxiliary Contacts: Provide each zone of lighting control with an additional auxiliary contact/relay, form C, dry contacts, rated for and compatible with the building automation system (BAS). Coordinate requirements with the Division 23 contractor.

C. PIR Type: Wall- or ceiling-mounted as indicated; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch.
2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a 360-degree circular area of 1000 sq. ft. when mounted on a 96-inch ceiling.
3. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 ft. when mounted on a 10 ft. high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 sq. ft. if positioned 84 inch above finished floor, unless otherwise indicated on the drawings.

D. Ultrasonic Type: Wall- or ceiling-mounted as indicated; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12-inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
2. Detection Coverage (Small Room): Detect occupancy anywhere within a 360-degree circular area of 600 sq. ft. when mounted on a 96-inch high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 ft. when mounted on a 10 ft. high ceiling in a corridor not wider than 14 ft..
6. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 sq. ft. if positioned 84-inch above finished floor.

E. Dual-Technology Type: Wall- or ceiling-mounted as indicated; detect occupants in coverage area using PIR/microphonics or PIR/ultrasonic detection methods. The type of detection technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch and detect a person of average size and weight moving not less than 12-inchin either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a 360-degree circular area of 1000 sq. ft.when mounted on a 96-inch-high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 sq. ft. if positioned 84-inchabove finished floor.

F. High-Ceiling Application PIR Type: Sensor suitable for mounting heights above 15-ft. and up to 45-ft.; ceiling-mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 12-inchminimum movement of any portion of a human body that presents a target of not less than 144 sq. inch.
2. Detection Coverage: Detect occupancy anywhere in a 360-degreee circular area of 1500 sq. ft. when mounted on a 30-ft. high ceiling. Provide adequate coverage to enable

sensors to be spaced 30-ft. apart in a square grid pattern, when mounted 30-ft. above the floor.

2.7 SWITCHBOX-MOUNTED OCCUPANCY AND VACANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design: Watt Stopper / Legrand.
2. Acuity Brands, Inc. (Sensor Switch).
3. Crestron Electronics, Inc.
4. Eaton / Greengate / Cooper Lighting Controls, Inc.
5. Encelium / Osram Sylvania, Inc.
6. Hubbell Building Automation.
7. Intelligent Lighting Controls, Inc.
8. Leviton Manufacturing Co.

B. General Requirements for Sensors: Automatic wall switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox using hardwired connection.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time-delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Vacancy Sensor Operation: Same as occupancy sensor operation, except lights turn on only when occupant manually operates the switch.
4. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
5. Switch Rating: Not less than 15 A consisting of LED lighting load.

C. Features and Performance Characteristics:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
2. Sensing Technology: PIR, unless indicated otherwise on drawings.
3. Switch Type: Single-pole, single switch-leg, unless indicated otherwise on drawings.
4. Field-selectable automatic "on" or manual "on".
5. Capable of controlling load in three-way application.
6. Voltage: Match the circuit voltage.
7. Concealed, field-adjustable, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes. Initial setting shall be 5 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.8 TIMER SWITCH, DIGITAL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Intermatic
2. Leviton
3. Paragon
4. Tork

B. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in 5-minute increments.

1. Rated 1000 W at 120 V(ac) and 277 V(ac) for LED lighting, and 1/4 hp at 120 V(ac).
2. Standards: Comply with UL 20.
3. Integral relay for connection to BAS.
4. Voltage: Match the circuit voltage.

2.9 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allen-Bradley/Rockwell Automation.
2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. GE Industrial Systems; Total Lighting Control.
4. Square D; Schneider Electric.
5. Siemens Energy and Automation, Inc.

B. Description: Multi-pole, electrically operated, and electrically held, unless indicated otherwise on the drawings, combination-type lighting contactors with non-fused hand-off-auto (HOA) switch, complying with NEMA ICS 2 and UL 508.

1. Multi-Pole Contactor: Provide the quantity of contacts indicated in the schedule shown on the drawings, which may include spares. Minimum quantity shall be two (2) contacts.
2. Current Rating for Switching: Listing or rating consistent with type of load served with 15 percent or less THD of normal load current). Minimum contact rating shall be 20 A 480 V(ac).
3. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
4. Enclosure: Comply with NEMA 250. Refer to drawings for specific applications.
5. Provide with HOA selector switch.

C. Interface with Building Automation System (BAS)

1. Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.
2. Monitoring and Control Points: Refer to schedule on drawings.

2.10 EQUIPMENT ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Food Preparation Areas (Kitchens): NEMA 250, Type 1, stainless steel.

2.11 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 LIGHTING CONTROL SYSTEMS, GENERAL

A. This contract shall include the complete design and application of lighting control systems. Determine all system components, cabling specifications, and programming required for complete and functional operation. If necessary, obtain clarification from Architect/Engineer prior to bidding regarding intent of contract documents.

B. Provide additional quantities and placement of sensors as needed to achieve coverage of area served at actual mounting heights.

C. The wiring methods indicated on the electrical drawings are to indicate design intent only. Approved manufacturer controls products may have different driver and sensor requirements and different wiring methods than what is shown on the electrical drawings. Contractors are required to familiarize themselves with all required wiring, additional part and pieces, required installation labor, etc., to provide for a complete installed system that meets the intent and functionality of the specified system.

D. The Contractor shall provide as part of the shop drawing submittals, complete lighting drawings including all wiring, equipment, equipment locations, etc. for the submitted system.

E. All costs shall be included in the bid for a complete operational system that meets the specified and designed system.

F. Control Intent: Control Intent includes, but is not limited to the following:

1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
2. Initial sensor and switching zones.
3. Initial time switch settings.

3.2 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION OF SENSORS

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies, as applicable.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.4 INSTALLATION OF CONTACTORS

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.5 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.

C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Include a neutral conductor connected to every “switch point”, such as wall-switch occupancy sensors, in accordance with NEC 404.2(C).

F. Ceiling-Mounted Sensors: Provide a minimum 8-ft. slack loop of extra control cabling so the Owner can readily modify the placement of sensors in the future.

G. Open cabling methods may be utilized above accessible ceilings for Class 2 wiring. All cabling in exposed areas, above inaccessible ceilings, and inside walls shall be installed in raceway.

H. IDENTIFICATION

I. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems.

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

J. Label switches and contactors with a unique designation as specified or as indicated on the drawings.

3.6 PROGRAMMING AND DEVICE SETTINGS

A. Manufacturer's Field Service and Commissioning: Engage a factory-authorized service representative to program, configure, test, and adjust components associated with each lighting control system and each lighting control device.

B. Initial Programming: Upon energizing luminaires associated with lighting control stations, each control station shall be programmed to provide basic manual on/off functions (so that no luminaire remains on or off 24/7 without manual control). This initial programming shall be provided prior to the manufacturer's factory-authorized technician performing their official system programming, configuration, startup, and system commissioning services.

C. Occupancy and Vacancy Sensor Settings and Adjustments

1. Position, aim, and adjust sensors to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
2. Lights shall turn on immediately after the light-switch, dimmer, or control station is engaged.
3. Lights must stay on while presence is detected.
4. Lights shall turn off after a preset time-delay commencing from the last moment presence was detected (corresponding to vacancy). The initial time-delay off setting shall be 10 minutes. Coordinate final settings directly with the Owner.
5. Provide a walk-though with the Owner's representative to confirm final settings and overall functionality.

D. Continuous Dimming Daylight-Harvesting, Field Settings, and Adjustments

1. Sensor operation shall be based upon a closed-loop control method. Placement, installation, and programming of device shall be in accordance with the manufacturer's installation instructions and recommendations.

2. During nighttime hours (no daylight), with all lights turned on and turned up 100%, determine the average lighting level (foot-candles) at 30-inches AFF throughout the space. This value shall be regarded as the design level.
3. Program and calibrate dimmable daylighting system to maintain this design level throughout the daylight hours and to turn the lights off completely whenever the lighting levels exceed the design levels by 10%.

E. BAS Controls – Coordination and Integration

1. Prior to bidding, coordinate with the Division 23 temperature control contractor for wiring, integrating, and programming of building automation system (BAS) to control lighting contactors as indicated. Refer to the drawings for specific zones of control and time scheduling requirements. Coordinate final settings directly with the Owner.

3.7 SYSTEM STARTUP AND SYSTEM COMMISSIONING

A. System Startup: Manufacturer’s authorized technician shall confirm proper installation and operation of system components.

B. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system. Provide notice no less than three weeks prior to a startup visit. Several business days may be required to confirm dates and times.

C. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:

1. Sensor parameters, time delays, sensitivities, and daylight-harvesting setpoints.
2. System programming (e.g., manual on, auto off, dimming levels, zone switching, etc.).

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Prepare test and inspection reports.

D. Manufacturer Field Services and Commissioning:

1. Engage factory-authorized service representative to perform field tests/inspections and to make any necessary adjustments to lighting control systems and devices.

3.9 ADJUSTING

A. Occupancy Adjustments: When requested by Owner within 12 months from the first day of business (FDOB), provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose, including up to 10 hours of labor plus the necessary travel time.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylight-harvesting controls, adjust set points and deadband controls to suit Owner's operations.

3.10 DEMONSTRATION

A. Coordinate demonstration of products and training of Owner’s maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section 017900 “Demonstration and Training” for requirements, excluding requirements related to video-recordings. Include in this contract training/demonstration time plus any necessary travel time/expenses.

1. Digital Lighting Management Systems: 2 hours
2. Lighting Contactors: 0.5 hour.
3. Daylight-Harvesting Sensors: 1 hour.
4. Occupancy and Vacancy Sensors: 1 hour.

3.11 MAINTENANCE

A. Software and Firmware Service Agreement: Install and program software upgrades that become available as specified above.

END OF SECTION 260923

SECTION 261219 - PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pad-mounted, liquid-filled, medium-voltage distribution transformers, with primary and secondary bushings within or without air-terminal enclosures.

B. Related Requirements:

1. Section 260500 "Common Work Results For Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

B. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted transformers and to provide a fully insulated connection. This is also called an "elbow connector."

C. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or nonload break, separable insulated connector (bushing).

D. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).

E. Elbow Connector: See "bushing elbow" above.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. For pad-mounted, liquid-filled, medium-voltage transformers.

a. Include plans and elevations showing major components and features.

1) Include plan view and cross section of equipment base, showing clearances, required workspace, and locations of penetrations for grounding and conduits.

b. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
c. Include single-line diagram.
d. Include list of materials.
e. Include nameplate data.
f. Manufacturer's published time-current curves of transformer line-side fuses, with transformer damage curve, inrush curve, and thru fault current indicated.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For transformers, signed by product manufacturer.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

B. Comply with IEEE C2.

C. Comply with IEEE C57.12.00.

2.2 PERFORMANCE REQUIREMENTS

A. Windings Material: Aluminum.

B. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, fully shielded, separable-elbow type, suitable for plugging into inserts provided in line-side section of transformer. Connected in each phase of incoming circuit and ahead of disconnecting device.

C. Winding Connections: Connection of windings and terminal markings must comply with IEEE C57.12.70.

D. Efficiency: Comply with 10 CFR 431, Subpart K.

E. Insulation: Transformer kVA rating must be as follows: Average winding temperature rise above 30 deg C ambient temperature must not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested in accordance with IEEE C57.12.90, using combination of connections and taps that give highest average winding temperature rise.

F. Tap Changer: External handle, for de-energized operation.

G. Tank: Sealed, with welded-on cover.

H. Enclosure Integrity: Comply with IEEE C57.12.28 for pad-mounted enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to public.

I. Mounting: Integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.

J. Insulating Liquids:

1. Mineral Oil: ASTM D3487, Type II, and tested for compliance with ASTM D117.

K. Sound level must comply with NEMA TR 1 requirements.

L. Corrosion Protection:

1. Transformer coating system must be factory applied, complying with requirements of IEEE C57.12.28, in manufacturer's standard color green.

2.3 THREE-PHASE TRANSFORMERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. ERMCO.
3. GE Power; General Electric Company.
4. Hitachi ABB Power Grids Ltd; ABB & Hitachi Joint Venture.
5. Howard Industries, Inc.
6. Prolec GE; A Xignux and General Electric Company Joint Venture.

B. Description:

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Comply with IEEE C57.12.26.

C. Compartment Construction:

1. Double-Compartment Construction: Individual compartments for line- and load-side sections, formed by steel isolating barriers that extend full height and depth of compartments, with hinged, lift-off doors and three-point latching, with stop in open position and provision for padlocking.

D. Primary Fusing: Designed and rated to provide thermal protection of transformer by sensing overcurrent and high liquid temperature.

1. 150 kV BIL current-limiting fuses, conforming to requirements of IEEE C37.47.
2. Interrupting Rating: 50 000 A(rms sym) at system voltage.
3. Fuse Assembly: Bayonet-type, liquid-immersed, expulsion fuses in series with liquid-immersed, partial-range, current-limiting fuses. Bayonet fuse must sense both high currents and high oil temperature to provide thermal protection to transformer.
4. Provide bayonet fuse assembly with oil retention valve and external drip shield inside housing to eliminate or minimize oil spills. Valve must close when fuse holder is removed and external drip shield is installed.
5. Provide conspicuously displayed warning adjacent to bayonet fuse(s), cautioning against removing or inserting fuses unless transformer has been de-energized and tank pressure has been released.

E. Line-Side Section: Dead-front design.

1. To connect primary cable, use separable insulated connectors. Bushings must be one-piece units, with ampere and BIL ratings same as connectors.
2. Bushing inserts:

    a. Conform to requirements of IEEE 386.
    b. Rated at 200 A, with voltage class matching connectors. Provide parking stand near bushing wells.
    c. Provide insulated protective caps for insulating and sealing out moisture from unused bushing inserts.

3. Bushing wells configured for loop-feed application.
4. Access to liquid-immersed fuses.
5. Dead-front surge arresters.
6. Tap-changer operator.
7. Load-Break Switch:

    a. Radial-feed, liquid-immersed type with voltage class and BIL matching that of separable connectors, with continuous current rating and load-break rating of 200 A, and make-and-latch rating of 12 kA(rms sym).

8. Ground pad.

F. Load-Side Section:

1. Bushings with spade terminals drilled for terminating number of conductors indicated on Drawings, and lugs that comply with requirements of Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

G. Capacities and Characteristics:

1. Power Rating: As indicated on drawings.
2. Voltage Ratings: As indicated on drawings.
3. Taps: Comply with IEEE C57.12.26 requirements.
4. Minimum Tested Impedance (Percent) at 85 deg C: 3.5.
5. K-factor: 1, complying with UL 1562.
6. Comply with FM Global Class No. 3990.

H. Transformer Accessories:

1. Drain and filter connection.
2. Filling and top filter press connections.
3. Pressure-vacuum gauge.
4. Dial-type analog thermometer with alarm contacts.
5. Magnetic liquid level indicator with high and low alarm contacts.
6. Automatically resetting pressure-relief device. Device flow must be as recommended by manufacturer.
7. Stainless steel ground connection pads.
8. Machine-engraved nameplate, made of anodized aluminum or stainless steel.
9. Sudden pressure relay for remote alarm or trip when internal transformer pressure rises at field-set rate. Provide with seal-in delay.

2.4 WARNING LABELS AND SIGNS

A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

1. High-Voltage Warning Label: Provide self-adhesive warning signs on outside of line-side compartment door(s). Sign legend must be "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. Word "DANGER" must be in white letters on red background and words "HIGH VOLTAGE" must be in black letters on white background.
2. Arc Flash Warning Label: Provide self-adhesive warning signs on outside of line-side compartment door(s), warning of potential electrical arc flash hazards and appropriate personal protective equipment required.

2.5 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Testing Administrant: Engage qualified electrical testing agency to evaluate transformer.

C. Testing: Test and inspect transformer in accordance with IEEE C57.12.90.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pad-mounted, liquid-filled, medium-voltage transformers upon delivery.

1. Upon delivery of transformers and prior to unloading, inspect equipment for damage that may have occurred during shipment or storage.
2. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, online- or load-side bushing parts, and at transformer base.
5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.
6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
7. Verify presence of polychlorinated biphenyl content labeling.
8. Unload transformers carefully, observing packing label warnings and handling instructions.
9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer termination compartments against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.
4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use lifting lugs when lifting transformers.
6. Use jacks only at corners of tank base plate.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with crane.

8. Use spreaders or lifting beam to obtain vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.

C. Storage:

1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting discrepancies or adverse conditions. Verify that effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.

D. Examine areas and space conditions for compliance with requirements for pad-mounted, liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.

E. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

F. Examine concrete bases for suitable conditions for transformer installation.

G. Pre-Installation Checks:

1. Verify removal of shipping bracing after placement.
2. Remove sample of insulating liquid in accordance with ASTM D923. Insulating-liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:

a. Dielectric Breakdown Voltage: ASTM D877 or ASTM D1816.
b. Acid Neutralization Number: ASTM D974.
c. Interfacial Tension: ASTM D971.
d. Color: ASTM D1500.
e. Visual Condition: ASTM D1524.
f. Water in Insulating Liquids: Comply with ASTM D1533.

H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at transformer location.

I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 260529 "Hangers and Supports for Electrical Systems."

B. Transformer must be installed level and plumb and must tilt less than 1.5 degrees while energized.

C. Comply with requirements for vibration isolation and seismic control devices specified in Section 260529 "Hangers and Supports for Electrical Systems".

D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and IEEE C2.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

1. For counterpoise, use tinned bare copper cable not smaller than 4/0 AWG, buried not less than 30 inch below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable, with no kinks or sharp bends.
2. Fence and equipment connections may not be smaller than 4 AWG. Ground fence at gate posts and corner posts and at intervals not exceeding 10 ft. Bond gate sections to fence posts using 1/8 by 1 inch tinned flexible braided copper strap and clamps.
3. Make joints in grounding conductors and loops by exothermic weld or compression connector.
4. Terminate grounding and bonding conductors on common equipment grounding terminal on transformer enclosure.
5. Complete transformer tank grounding and lightning arrester connections prior to making other electrical connections.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that

could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

3.4 SIGNS AND LABELS

A. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. General Field-Testing Requirements:

a. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B.
b. Perform visual and mechanical inspections and electrical tests. Certify compliance with test parameters.
c. After installing transformer but before primary is energized, verify that grounding system at transformer is tested at specified value or less.
d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
e. Visual and Mechanical Inspection:

1) Verify equipment nameplate data complies with Contract Documents.
2) Inspect bolted electrical connections for high resistance using one of the following two methods:

a) Use low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

2. Medium-Voltage Surge Arrester Field Tests:

a. Visual and Mechanical Inspection:

1) Inspect physical and mechanical condition.
2) Verify arresters are clean.
3) Verify that ground leads on devices are individually attached to ground bus or ground electrode.

b. Electrical Test:

1) Perform insulation-resistance test on arresters, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to comply with recommended minimum insulation resistance listed in that table.
2) Perform watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

3. Liquid-Filled Transformer Field Tests:

a. Visual and Mechanical Inspection:

1) Test dew point of tank gases if applicable.
2) Inspect anchorage, alignment, and grounding.
3) Verify bushings are clean.
4) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
5) Verify that liquid level in tanks is within manufacturer's published tolerances.
6) Perform specific inspections and mechanical tests recommended by manufacturer.
7) Verify presence of transformer surge arresters and that their ratings are as specified.
8) Verify that as-left tap connections are as specified.

b. Electrical Tests:

1) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index may not be less than 1.0.
2) Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.3.
3) Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values may not be less than 1 MΩ at 500 V(dc).
4) Perform Optional Field Tests:

a) Perform turns-ratio tests at tap positions. Turns-ratio test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
b) Perform excitation-current test on each phase. Typical excitation-current test data pattern for three-legged core transformer is two

similar current readings and one lower current reading. Investigate and correct if test shows different pattern.

c) Measure resistance of windings at tap connections, and record temperature-corrected winding-resistance values in Operations and Maintenance Manual.

d) Perform applied-voltage test online- and load-side windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9. This test is not required for single-phase transformers and for three-phase wye-wye-connected transformers.

5) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

6) Remove sample of insulating liquid in accordance with ASTM D923 and perform dissolved-gas analysis in accordance with IEEE C57.104 or ASTM D3612.

B. Nonconforming Work:

1. Equipment and devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace malfunctioning units and retest.

C. Prepare test and inspection reports. Record as left set points of adjustable devices.

D. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of transformers. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

a. Adjust transformer taps.
b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
4. Report:

a. Prepare written report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove necessary covers prior to inspection.

1. Instrument: Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1 deg C at 30 deg C.
2. Record of Infrared Inspection: Prepare certified report that identifies testing technician and equipment used, and lists results as follows:

a. Description of equipment to be tested.
b. Discrepancies.
c. Temperature difference between area of concern and reference area.
d. Probable cause of temperature difference.
e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
f. Identify load conditions at time of inspection.
g. Provide photographs and thermograms of deficient area.

3. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION 261219

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).
2. Acme Electric Corporation.
3. Eaton.
4. Schneider Electric USA (Square D).
5. Siemens Industry, Inc., Energy Management Division.
6. Sola/Hevi-Duty; Emerson Electric Co

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Comply with NFPA 70.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Grounded to enclosure.

C. Coils: Continuous windings without splices except for taps.

1. Coil Material: Aluminum.
2. Internal Coil Connections: Brazed or pressure type.

3. Terminal Connections: Welded.

D. Enclosure: Ventilated.

1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Finish: Comply with NEMA 250.

E. Taps for Transformers 3 kVA and Smaller: None.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

H. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 80 deg C rise above 40 deg C ambient temperature.

J. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

K. Wall Brackets: Wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.

L. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:

1. 9.00 kVA and Less: 40 dBA.
2. 9.01 to 30.00 kVA: 45 dBA.
3. 30.01 to 50.00 kVA: 45 dBA for K-factors of 1, 4, and 9.
4. 50.01 to 150.00 kVA: 50 dBA for K-factors of 1, 4, and 9.
5. 150.01 to 300.00 kVA: 55 dBA for K-factors of 1, 4, and 9.
6. 300.01 to 500.00 kVA: 60 dBA for K-factors of 1, 4, and 9.
7. 500.01 to 700.00: 62 dBA for K-factors of 1, 4, and 9.
8. 700.01 to 1000.00: 64 dBA for K-factors of 1, 4, and 9.

2.4 IDENTIFICATION

A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
2. Ratio tests at rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:

    a. High voltage to ground.
    b. Low voltage to ground.
    c. High voltage to low voltage.

9. Temperature tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection.

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.

d. Verify the unit is clean.
e. Perform specific inspections and mechanical tests recommended by manufacturer.
f. Verify that as-left tap connections are as specified.
g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Measure resistance at each winding, tap, and bolted connection.
b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V or less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

B. Related Requirements

1. Section 260570 “Overcurrent Protection Studies” for selecting overcurrent devices, adjustment of breakers, and arc-flash analysis and arc-flash label requirements.

1.3 ACTION SUBMITTALS

A. Submit written Short Circuit and Coordination Studies, Arc-Flash Hazard Analysis and reports, as required by Section 260570 “Overcurrent Protection Studies” concurrently or prior to submittals required by this section.

B. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.

1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

C. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.

5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

D. Delegated Design Submittals:

1. For arc-flash hazard analysis.
2. For arc-flash labels.
3. For Short Circuit Studies
4. For Coordination Studies

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Routine maintenance requirements for switchboards and all installed components.
b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.9 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F.
b. Altitude: Not exceeding 6600 feet.

1.10 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces.

Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from the first day of business.

B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from the first day of business.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).
2. Eaton.
3. Schneider Electric USA (Square D).
4. Siemens Industry, Inc., Energy Management Division.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

I. Nominal System Voltage: 480Y/277 V.

J. Main-Bus Continuous: As indicated on one-line diagram.

K. Indoor Enclosures: Steel, NEMA 250, Type 1.

L. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

M. Barriers: Between adjacent switchboard sections.

N. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

O. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

P. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.

Q. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

R. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

S. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
2. Phase- and Neutral-Bus Material: Hard-drawn copper or tin-plated aluminum of 98 percent conductivity.
3. Copper or aluminum feeder circuit-breaker line connections.
4. Ground Bus: Minimum-size required by UL 891, hard-drawn copper or aluminum of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.

5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
6. Disconnect Links:

    a. Isolate neutral bus from incoming neutral conductors.
    b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

T. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 SURGE PROTECTION DEVICES

A. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 2.

B. Provide SPD on switchboards that supply power to emergency power systems as defined by NEC 700.

C. Features and Accessories:

1. Integral disconnect switch.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Indicator light display for protection status.
4. Form-C contacts rated at 2 A and 24-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
5. Surge counter.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 300 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Line to Line: 2000 V for 480Y/277 V.

F. SCCR: Equal or exceed 200 kA.

G. Nominal RATING: 20 kA.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Provide Arc Energy Reducing Maintenance Switch on any breaker or fusible disconnect switch which can be adjusted 1,200 A or higher per NEC 240.67 and 240.87.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents. Circuit breaker types, frame sizes, and functionality shall be as required to meet the overcurrent device selectivity requirements, but as a minimum shall be:

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time adjustments.
    d. Ground-fault pickup level, time delay, and I squared t response.

3. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Arc Energy Reducing Maintenance Switch on any breaker which can be adjusted 1,200 A or higher per NEC 240.87.

C. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Time adjustments for long- and short-time pickup.
    c. Ground-fault pickup level, time delay, and I squared t response.

4. Arc Energy Reducing Maintenance Switch on any breaker which can be adjusted 1,200 A or higher per NEC 240.87.

2.4 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

B. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

C. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with manufacturer's instructions.

2.7 IDENTIFICATION

A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.

1. Nameplate: At least 0.032-inch- thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.

B. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

C. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

D. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to switchboards.
6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, surge protection devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Install spare-fuse cabinet.

H. Comply with NECA 1.

3.3 CONNECTIONS

A. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

B. Support and secure conductors within the switchboard according to NFPA 70.

C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Acceptance Testing:

a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment per NFPA 70.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Perform the following infrared scan tests and inspections, and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Switchboard will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260570 "Overcurrent Protection Studies."

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. HID: High-intensity discharge.

E. MCCB: Molded-case circuit breaker.

F. SPD: Surge protective device.

G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Submit written Short Circuit and Coordination Studies, Arc-Flash Hazard Analysis and reports, as required by Section 260570 “Overcurrent Protection Studies” concurrently or prior to submittals required by this section.

B. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards Submit final version to match installed conditions and additional loads.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
    b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from the first day of business.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: Five years from the first day of business.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).
2. Eaton.
3. Schneider Electric USA (Square D).
4. Siemens Industry, Inc., Energy Management Division

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Enclosures: Flush and Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.
c. Kitchen Areas: NEMA 250, Type 4X.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Height: 84 inches maximum.
3. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.

G. Incoming Mains:

1. Location: Convertible between top and bottom.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper or tin-plated aluminum, 98 percent conductivity.

a. Plating shall run entire length of bus.
b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.

3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

I. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper or tin-plated aluminum, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.

J. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

K. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Future spaces: number as indicated in panelboard schedules on the drawings.

L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 POWER PANELBOARDS

A. Panelboards: NEMA PB 1, distribution type.

B. Mains: As indicated on plans.

C. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: As indicated on plans.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Provide Arc Energy Reducing Maintenance Switch on any breaker or fusible disconnect switch which can be adjusted 1,200 A or higher per NEC 240.87.

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents. Circuit breaker types, frame sizes, and functionality shall be as required to meet the overcurrent device selectivity requirements as noted in 26 05 70 Coordination Study, but not less than as noted below:

1. Thermal-Magnetic Circuit Breakers:

    a. Inverse time-current element for low-level overloads.
    b. Instantaneous magnetic trip element for short circuits.
    c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Electronic Trip Circuit Breakers:

    a. RMS sensing.
    b. Field-replaceable rating plug or electronic trip.
    c. Digital display of settings, trip targets, and indicated metering displays.
    d. Multi-button keypad to access programmable functions and monitored data.
    e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
    f. Integral test jack for connection to portable test set or laptop computer.
    g. Field-Adjustable Settings:

        1) Instantaneous trip.
        2) Long- and short-time pickup levels.

3) Long- and short-time adjustments.
4) Ground-fault pickup level, time delay, and I squared T response.

3. Subfeed Circuit Breakers: Vertically mounted.
4. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Breaker handle indicates tripped status.
c. UL listed for reverse connection without restrictive line or load ratings.
d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
g. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
i. Multipole units enclosed in a single housing with a single handle.

2.6 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:

1. Install floor panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Mount top of trim 90 inches above finished floor unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mount surface-mounted panelboards to steel slotted supports 1-1/4 inch in depth. Orient steel slotted supports vertically.

J. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

L. Install filler plates in unused spaces.

M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

N. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260570 "Overcurrent Protection Studies."

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Standard-grade receptacles, 125 V, 20 A.
2. GFCI receptacles, 125 V, 20 A.
3. Tamper-Resistant receptacles
4. Twist-locking receptacles.
5. Toggle switches, 120/277 V, 20 A.
6. Wall plates.
7. Poke-through assemblies.

1.3 DEFINITIONS

A. AFCI: Arc-fault circuit interrupter.

B. BAS: Building automation system.

C. EMI: Electromagnetic interference.

D. GFCI: Ground-fault circuit interrupter.

E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

F. RFI: Radio-frequency interference.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Poke-Through, Fire-Rated Closure Plugs: One for every five-floor service outlets installed, but no fewer than two.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with requirements in this Section.

F. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.

G. Device Color:

1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.

H. Wall Plate Color: For plastic covers, match device color.

I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

J. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Straight Blade Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5361 (single), 5362 (duplex).
b. Hubbell; HBL5361 (single), 5362 (duplex).
c. Leviton; 5361 (single), 5362 (duplex).
d. Pass & Seymour; 5361 (single), 5362 (duplex).

2. Description: Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 and FS W-C-596.

B. Tamper-Resistant Duplex Receptacles, 125 V, 20 A:

1. Provide tamper resistant versions of the straight blade receptacles series specified above.
2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 and FS W-C-596.
5. Products: Subject to compliance with the requirement, provide one of the following:

a. Cooper TRBR20
b. Hubbell BR20TR
c. Leviton TBR20
d. Legrand/P&S TR5362

6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Weather-Resistant Duplex Receptacle, 125 V, 20 A:

1. Provide weather resistant version of the straight blade receptacles series specified above.
2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-20R.

4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

D. Tamper- and Weather-Resistant Duplex Receptacles, 125 V, 20 A:

1. Provide tamper resistant and weather resistant version of the straight blade receptacles series specified above.
2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.3 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper: SGF20
   b. Hubbell: GFRST20_ST (AutoGuard™)
   c. Leviton: G5362
   d. Pass & Seymour: 2095

2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Feed through.
5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

B. Tamper-Resistant Duplex GFCI Receptacles, 125 V, 20 A:

1. Provide tamper resistant versions of the straight blade receptacles series specified above.
2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Feed through.
5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:

1. Provide tamper resistant and weather resistant version of the straight blade receptacles series specified above.

2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Feed through.
5. Standards: Comply with UL 498 and UL 943 Class A.
6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.4 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Receptacles:

1. Configuration: NEMA WD 6, Configuration as noted on Drawings
2. Standards: Comply with UL 498.

2.5 TOGGLE SWITCHES, 120/277 V, 20 A

A. Single-Pole Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper: CSB120
   b. Hubbell: CSB120
   c. Leviton: 1221-2
   d. Pass & Seymour: CSB20AC1

2. Standards: Comply with UL 20 and FS W-S-896.

B. Three-Way Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper: CSB320
   b. Hubbell: CSB320
   c. Leviton: 1223-2
   d. Pass & Seymour: CSB20AC3

2. Comply with UL 20 and FS W-S-896.

C. Four-Way Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper: CSB420
   b. Hubbell: CSB420
   c. Leviton: 1224-2
   d. Pass & Seymour: CSB20AC4

2. Standards: Comply with UL 20 and FS W-S-896.

2.6 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Indoor Damp Locations: Cast aluminum with spring-loaded lift cover and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, thermoplastic with lockable in-use cover.

2.7 POKE-THROUGH ASSEMBLIES

A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multi-channeled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.

B. Standards: Comply with scrub water exclusion requirements in UL 514.

C. Service-Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks.

D. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.

E. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.

F. Closure Plug: Arranged to close unused cored openings and reestablish fire rating of floor.

G. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, four-pair cables.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

    a. In existing buildings, match the configuration of existing devices.

F. Tamper Resistant Receptacles: Provide as required by the current adopted NEC 406.12. regardless of how receptacles are indicated on the drawings.

G. Wet locations: Provide weatherproof cover plates at exterior and interior wet locations as required by the current adopted NEC whether indicated as such on the drawings or not, in addition to those devices that are specifically denoted on the drawings with a “W” or “WP” to receive weatherproof covers.

H. Maintenance Receptacles for HVAC equipment: whether denoted on the drawing or not, provide accessible 125V, 20A, duplex GFCI receptacle located within 25 feet of HVAC equipment per current adopted NEC. Connect to 20-amp general purpose circuit.

I. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

J. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

K. Adjust locations of floor devices to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

B. Provide GFCI receptacles or GFCI breaker as required by NEC 210.8 at the following locations whether denoted on the drawings or not:

1. Within 6-feet of the outside edge of ta sink or other “wet location” applications unless exception is applicable by the most current adopted NEC.
2. Restrooms, locker rooms, and bathing/showering areas.
3. food service preparation areas and/or kitchen areas.
4. Outdoors, including mechanical rooftop units unless exception is applicable by the most current adopted NEC.
5. Garages and maintenance areas where electrical portable tools are used.
6. Electric water coolers.
7. Vending machines.
8. Other locations as required by the current adopted edition of the NEC.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
3. Using the test plug, verify that the device and its outlet box are securely mounted.
4. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:

    a. Enclosed switches.

2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," include the following:

1. Current-limitation curves for fuses with current-limiting characteristics.
2. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project.
3. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bussmann by Eaton.
2. Littelfuse.
3. Mersen.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC , time delay.
2. Type CC: 600-V, zero- to 30-A rating, 200 Kaic, time delay.
3. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with **15** percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Motor Branch Circuits: Class RK1, time delay.
2. Large Motor Branch (601-4000 A): Class L, time delay.
3. Power Electronics Circuits: Class J, high speed.
4. Other Branch Circuits: Class J, time delay.
5. Control Transformer Circuits: Class CC, time delay, control transformer duty.
6. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Architect.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 – DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Motor-rated toggle switches.
4. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed disconnect switch, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. Manufacturer's written instructions for testing and adjusting enclosed disconnect switches to include in emergency, operation, and maintenance manuals.

B. Warranty documents.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Greater than one (1) year from the first day of business.

    a. If the manufacturer’s warranty commences upon the date materials are delivered, then the manufacturer’s warranty period must be at least two (2) years to meet the requirement stated above.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed disconnect switches, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed disconnect switches, including clearances between enclosures, and adjacent surfaces and other items. Comply with maximum dimensions, if indicated, and required workspace clearances and actual space available at mounting location.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

2.3 FUSIBLE SWITCHES

A. Type HD, Heavy Duty:

1. Single Throw: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses. Lockable handle with capability to accept three padlocks and interlocked with cover in closed position.

B. Voltage Rating, Ampere Rating, and Quantity of Poles: Refer to the Drawings.

C. Fuse Type, Rating, and Quantities: Refer to the Drawings.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors. Provide for each application in which the feeder contains a grounded conductor (neutral wire).
3. Lugs: Mechanical type, suitable for number, size, and conductor material.
4. Provide wherever the disconnect switch serves as an electric service disconnect or wherever indicated on the Drawings.

2.4 NONFUSIBLE SWITCHES

A. Type HD, Heavy Duty:

1. Single Throw: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks and interlocked with cover in closed position.

B. Voltage Rating, Ampere Rating, and Quantity of Poles: Refer to the Drawings.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors. Provide for each application in which the feeder contains a grounded conductor (neutral wire).
3. Lugs: Mechanical type, suitable for number, size, and conductor material.
4. Provide wherever the disconnect switch serves as an electric service disconnect or wherever indicated on the Drawings.

2.5 MOTOR-RATED TOGGLE SWITCHES

A. Motor-Starting Switches (without motor overload protection): "Quick-make, quick-break" heavy-duty toggle; non-fusible.

1. Lockable in the off position.
2. Factory markings indicating whether unit is off or on.
3. Ratings: 600-V ac, 30-A.
4. Quantity of Poles: As required or as indicated on the Drawings.
5. Surface-mounted in unfinished spaces.
6. Flush-mounted with stainless steel faceplate in finished spaces.
7. Red Pilot light: To be included if indicated on the Drawings.

2.6 ENCLOSURES

A. UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Environmental Rating Applications:

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R, galvannealed steel.
3. Food Service Areas (Kitchens): NEMA 250, Type 4X, stainless steel.

C. Enclosure Finish:

1. Type 1, Steel: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel.
2. Types 1, 3R, 12, Galvannealed Steel: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel.
3. Type 1, 4-4X, Stainless Steel: A brush finish on Type 304 stainless steel.

D. Conduit Entry: NEMA 250 Types 4, 4X enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both end-walls.

E. Operating Mechanism:

1. NEMA 250 Type 1: The operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover.
2. NEMA 250 Type 3R: The operating handle shall be directly operable through the dead front trim of the enclosure.

3. NEMA 250 Type 4, 4X stainless steel, shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the disconnect is in the closed position (ON) and to prevent closing the circuit (ON) when the enclosure cover is open.
4. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed disconnect switches for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 INSTALLATION

A. Coordinate layout and installation of disconnect switches, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted disconnect switches with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NFPA 70 and NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform Tests and Inspections:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that the unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Measure contact resistance across each switchblade fuse holder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of

insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

B. Disconnect switches will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION 262816

SECTION 262818 – CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Molded-case circuit breakers (MCCBs).
2. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Manufacturer's written instructions for testing and adjusting enclosed circuit breakers to include in emergency, operation, and maintenance manuals.

B. Warranty documents.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Greater than one (1) year from the first day of business.

a. If the manufacturer’s warranty commences upon the date materials are delivered, then the manufacturer’s warranty period must be at least two (2) years to meet the requirement stated above.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed circuit breakers, including clearances between enclosures, adjacent surfaces, and other items. Comply with maximum dimensions, if indicated, and required workspace clearances and actual space available at mounting location.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

2.3 MOLDED-CASE CIRCUIT BREAKERS (MCCBs)

A. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

B. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

C. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated, unless indicated otherwise.

D. MCCBs shall be equipped with a device for locking in the isolated position.

E. Lugs shall be suitable for 167 deg F rated wire.

F. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

G. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

H. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

I. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I-squared t response.

J. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

K. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

L. Voltage Rating, Ampere Rating, and Quantity of Poles: Refer to the Drawings.

M. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
4. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors. Provide for each application in which the feeder contains a grounded conductor (neutral wire).
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.4 ENCLOSURES

A. UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Environmental Rating Applications:

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R, galvannealed steel.
3. Food Service Areas (Kitchens): NEMA 250, Type 4X, stainless steel.

C. Enclosure Finish:

1. Type 1, Steel: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel.
2. Types 1, 3R, 12, Galvannealed Steel: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel.
3. Type 1, 4-4X, Stainless Steel: A brush finish on Type 304 stainless steel.

D. Conduit Entry: NEMA 250 Types 4, 4X enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both end-walls.

E. Operating Mechanism:

1. NEMA 250 Type 1: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover.
2. NEMA 250 Type 3R: The circuit-breaker operating handle shall be directly operable through the dead front trim of the enclosure.
3. NEMA 250 Type 4, 4X stainless steel shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
4. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked

position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 INSTALLATION

A. Coordinate layout and installation of circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted circuit breakers with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Comply with NFPA 70 and NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform Tests and Inspections:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
g. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
h. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

B. Circuit breakers will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260570 "Overcurrent Protective Device Studies."

END OF SECTION 262818

SECTION 265100 - LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. LED interior lighting.
2. LED exterior lighting.
3. Exit lighting.
4. Luminaire accessories and support components.

B. Related Requirements:

1. Section 260923 "Lighting Control Systems and Devices" for automatic control of lighting, including controllers/dimmers, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. EPA: Effective projected area (as it relates to the wind force exerted on an object, in accordance with the standard, AASHTO LTS-5).

D. Fixture: See "Luminaire."

E. IP: International Protection or Ingress Protection Rating.

F. LED: Light-emitting diode.

G. Lumen: Measured delivered output of luminaire.

H. Luminaire: Complete lighting unit, including light source, reflector, integral or remote driver, internal or external emergency power unit, circuitry, lens, diffuser, housing, and accessories.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description, profiles, and dimensions of luminaires.
4. Include data on EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
5. Include finishes for lighting poles and luminaire-supporting devices.
6. Anchor bolts.
7. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
8. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79 and IES LM-80.
9. Use same luminaire designations as indicated on Drawings.

B. Shop Drawings: For nonstandard or custom luminaires or pole-mounted luminaires.

1. Include plans, elevations, sections, unique configurations, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Finish/Color Samples for Initial Selection or Verification: As specified for specific luminaire types on the Luminaire Schedule for each type of luminaire requiring a custom factory-applied finishes/colors.

1. Include samples of luminaires and accessories involving color and finish selection.
2. Include samples for each type of lighting pole, standard, and luminaire-supporting device and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires, poles, and lighting systems to include in operation and maintenance manuals.

B. Warranty documents.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications:

1. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

B. IESNA RP-16-05 Addendum “A”: Industry-standard nomenclature and definitions of lighting terms and lighting technologies, including solid-state (LED) luminaires.

C. UL Compliance: Comply with UL 1598 and listed for wet locations, as specified.

D. Source Limitations:

1. Provide luminaires from a single manufacturer for each luminaire type
2. Obtain poles from single manufacturer or producer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

B. Package aluminum poles for shipping according to ASTM B660.

C. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

D. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.9 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Structural failures, including luminaire support components.
2. Faulty operation of luminaires and accessories.
3. Deterioration or corrosion of metals, metal finishes, color retention, and other materials beyond normal weathering.

B. Luminaire and Pole Warranty Period: Greater than four (4) years from date of Substantial Completion.

1. If the manufacturer’s warranty commences upon the date materials are delivered, then the manufacturer’s warranty period must be at least five (5) years to meet the requirement stated above.

C. Battery Warranty Period:

1. Full Warranty: One (1) year.
2. Pro Rata: Nine (9) years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance:

1. Luminaires shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
2. Luminaires and lamps shall be labeled vibration and shock resistant.
3. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."
4. Component Importance Factor: 1.0.

B. Structural Characteristics: Comply with AASHTO LTS-6-M.

C. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.

D. Live Load: Single load of 500 lbf distributed according to AASHTO LTS-6-M.

E. Ice Load: Load of 3 lbf/sq. ft., applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.

F. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.

G. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.

H. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

I. Ambient Temperature (Indoor Lighting): 5 to 104 deg F.

J. Exterior Temperature (Outdoor Lighting): minus 20 to plus 120 deg F (-29 to +50 deg C).

1. Relative Humidity: Zero to 95 percent.

K. Altitude: Sea level to 1000 feet.

2.2 LUMINAIRE REQUIREMENTS

A. Luminaire Types and Acceptable Manufacturers: As indicated on the Drawings. Refer to the Luminaire Schedule.

1. Model numbers shall not be regarded as complete or entirely accurate. Do not order products based solely on a model number. For each luminaire type, the contractor shall reconcile its description, including options and accessories, with its intended application derived from relevant information conveyed throughout the entirety of contract documents.
2. The manufacturer listed first for each luminaire type shall be regarded as the Basis of Design. Alternative products by other listed manufacturers must be at least equivalent in style, quality, features, and performance to that of the Basis of Design.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Factory-Applied Labels: Comply with UL 1598. Include CCT and CRI ratings. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

D. Recessed luminaires shall comply with NEMA LE 4.

2.3 LED LUMINAIRES

A. Delivered lumen output as indicated on the Luminaire Schedule.

B. IESNA LM-79 compliant, latest edition.

C. IESNA LM-80 compliant, latest edition; 50,000 hours minimum, unless otherwise noted.

D. CRI and CCT as indicated on Luminaire Schedule in accordance with ANSI C78.377.

E. NEMA.SSL-1 compliant for operational characteristics and electrical safety of LED drivers and power supplies. ANSI/NEMA C82.77 compliant for maximum allowable harmonic distortion produced by power supplies/drivers.

F. Power Factor > 0.9, unless noted otherwise.

G. Total Harmonic Distortion (THD) < 20%, unless noted otherwise.

H. Provide integral Type 4 surge protective device (SPD) rated for 10 kA peak surge per UL 1449 standards.

I. Internal or External Type Emergency Power Unit:

1. Self-contained, modular, battery-inverter unit, factory mounted on luminaire, within luminaire body, or remotely, as indicated on the Drawings.

2. Emergency Connection: Operate luminaire continuously at least 90-percent of rated lumen output of luminaire upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Remote Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space. Refer to Drawings.

    a. Tester/indicator shall be contained within a single-gang white faceplate with factory labeling. Faceplate shall be unbreakable thermoplastic.
    b. Mount tester/indicator adjacent to its associated lighting fixture. If the lighting fixture is installed in a suspended grid ceiling, tester/indicator shall be mounted flush and centered in an adjacent ceiling tile.
    c. Furnish and install wiring between emergency lighting unit and tester/indicator in accordance with these specifications and the manufacturer's instructions.
    d. Tester/indicator light shall not be mounted integral to the lighting fixture. If tester/indicator is furnished integral to the lighting fixture, the lighting fixture shall be regarded as damaged, and shall be replaced by this contractor.

7. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.4 EXIT SIGNS

1. General Characteristics: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
2. Internally Lighted Sign:

    a. LED; 100,000 hours minimum rated lamp life.
    b. Self-Powered Exit Signs (Battery Type): Provide internal emergency power unit. Refer to the Luminaire Schedule for application.

        1) Integral automatic charger in a self-contained power pack.
        2) Battery: Sealed, maintenance-free, nickel-cadmium type.
        3) Charger: Fully automatic, solid-state type with sealed transfer relay.
        4) Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
        5) LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
        6) Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for sheet steel.
3. Epoxy-coated.

C. Stainless Steel:

1. Manufacturer's standard grade.
2. Manufacturer's standard type, ASTM A240/240M.

D. Galvanized Steel: ASTM A653/A653M.

E. Aluminum: ASTM B209. Corrosion-resistant.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit servicing without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during servicing and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

G. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation (UV-stabilized). Lens Thickness: At least 0.125 inch minimum, unless otherwise indicated.

H. Glass Lenses, Diffusers, or Globes: Annealed crystal glass, tempered Fresnel glass, unless otherwise indicated. Acrylic lenses

2.6 FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Finishes and Color Selections: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping.

1. Finishes/colors to be selected by the Architect/Engineer from the manufacturer's full range of standard finishes/colors during the review of action submittals, unless the color is specifically indicated on the Luminaire Schedule.
2. If noted on the Luminaire Schedule, provide custom color matching Architect's color sample or RAL designation.
3. For pole-mounted luminaires, match finish process and color of pole, unless otherwise indicated.

D. Factory-Applied Finish for Aluminum Luminaires and Poles: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

E. Factory-Applied Finish for Steel Luminaires and Poles: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

F. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Powder Coat: Comply with AAMA 2604. Electrostatic-applied powder coating; single application and cured to a minimum 2.5- to 3.5-mil dry film thickness. Coat interior and exterior of pole for equal corrosion protection

2.7 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12-gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

2.8 POLES

A. Pole Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Valmont.
2. WJM Poles.
3. Cooper Lighting.
4. Kim Lighting.
5. Or same manufacturer as pole-mounted luminaire.

B. Pole Heights: As indicated on the Drawings. Refer to the Luminaire Schedule.

C. Concrete Base: Refer to the Drawings.

D. Structural Characteristics: Comply with AASHTO LTS-4.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
3. The minimum EPA capacity of each pole shall exceed 200% of the total fixture head EPA value attached to each pole at 90 mph. This provides a safety factor, as well as countering long-term fatigue and/or accommodating an additional fixture head in the future.

E. Steel Poles

1. Poles: Comply with ASTM A500/A500M, Grade B carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.

a. Shape: Round, straight.
b. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

F. Prestressed Concrete Poles

1. Poles: Comply with ASTM C1089.

a. Shape: Square, tapered.
b. Mounting Provisions: Embedded.

c. Finishing: Capped at top and plugged at bottom. Seat each reinforcing strand with epoxy adhesive.
d. Grounding: Continuous copper ground wire cast into pole. Terminate at top of pole.
e. Raceway: Smooth, internal, and not less than 3 inches in diameter.

2. Concrete: Minimum 28-day compressive strength of 7000 psi (48 265 kPa).
3. Cured with wet steam and aged for a minimum of 15 days prior to installation.
4. Reinforcement: Reinforcing bars complying with ASTM A615/A615M.
5. Surface Treatment: Hard, nonporous, and resistant to water, frost, and road and soil chemicals; and shall have a maximum water-absorption rate of 3 percent.
6. Finish Texture: Smooth, uncolored finish with no cracks. Top surface of each pole shall be troweled until all projections, depressions, and irregularities have been removed and the entire surface has a smooth texture and neat lines. Square corners and sharp edges shall be tooled to form smooth, chamfered corners.
7. Pole Brackets: Comply with ANSI C136.31.

G. Fasteners: Stainless steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dipped galvanized after fabrication unless otherwise indicated.

H. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.

I. Pole Accessories: Provide for each pole, unless indicated otherwise on the Drawings.

1. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.
2. Provide watertight pole cap atop each pole.
3. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported load multiplied by a 5.0 safety factor.
4. Duplex Receptacle: Comply with requirements in Section 262726 "Wiring Devices."
5. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

J. Mounting Hardware

1. Anchor Bolts: Manufactured to ASTM F1554, Grade 55 with a minimum yield strength of 55,000 psi (380 000 kPa).

a. Galvanizing: Hot-dipped galvanized according to ASTM A153, Class C.
b. Threading: Uniform National Coarse, Class 2A.

2. Nuts: ASTM A563, Grade A, Heavy-Hex.

a. Galvanizing: Hot-dipped galvanized according to ASTM A153, Class C.
b. Two (2) nuts provided per anchor bolt, shipped with nuts pre-assembled to the anchor bolts.

3. Washers: ASTM F436, Type 1.

a. Galvanizing: Hot-dipped galvanized according to ASTM A153, Class C.
b. Two (2) washers provided per anchor bolt.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, roofs, canopy ceilings, and overhang ceilings for suitable conditions where luminaires will be installed.

D. Examine poles, luminaire-mounting devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

C. Coordinate layout and installation of luminaires with other construction. Do not modify layout or locations of luminaires without documented approval to do so, unless indicated otherwise on the Drawings.

D. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

E. Adjust luminaires that require field adjustment or aiming to provide optimum illumination. Coordinate and confirm final adjustments with Owner.

F. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

G. Fasten luminaire to structural support.

H. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and servicing.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

I. Flush-Mounted Luminaires:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

J. Wall-Mounted Luminaires:

1. Attached to structural members in walls or a minimum 20-gauge or 1/8-inch thick backing plate attached to wall structural members.
2. Attached using through bolts and backing plates on either side of wall as recommended by luminaire manufacturer.
3. Do not attach luminaires directly to gypsum board.

K. Suspended Luminaires:

1. Pendant mount, where indicated, minimum 5/32-inch-diameter aircraft cable supports, adjustable, and quantity of supports as indicated or as recommended by luminaire manufacturer, whichever is greater.
2. Hook mount, where applicable.
3. Rods: Where longer than 48 inches, brace to limit swinging.
4. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
5. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod or wire support as indicated for suspension for each unit length of luminaire chassis, including one at each end.
6. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

L. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.

M. Ground-Mounted Luminaires and Bollard Luminaires:

1. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified under Division 03.

N. Pole-Mounted Luminaires:

1. Where applicable, adjust photoelectric devices to prevent false operation of relay by artificial light sources, favoring a north orientation.

O. Poles Foundations:

1. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
2. Pre-Cast Foundations: Factory fabricated, with structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
3. Anchor Bolts: Install plumb using manufacturer-supplied steel or plywood template, uniformly spaced.

P. Pole Installation:

1. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.
2. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.

    a. Fire Hydrants and Water Piping: 60 inches.
    b. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet.
    c. Trees: 15 feet from tree trunk.

3. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified under Division 03.
4. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

    a. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
    b. Install base covers unless otherwise indicated.
    c. Use a short piece of 1/2-inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

5. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of the

adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1-inch below top of concrete slab.

6. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

Q. Pole Grounding: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.

a. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
b. Install grounding conductor and conductor protector.
c. Ground metallic components of pole accessories and foundation.

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify settings, programming, functions, and operation of components integral to the luminaire, whether dimming drivers, integral presence sensors, or photoelectric sensors—in addition to other control systems specified in Section 260923 “Lighting Control Systems and Devices.”
3. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
4. Inspect luminaires and poles for nicks, mars, dents, scratches, and other damage.

C. Luminaire will be considered defective if it does not pass operation tests and inspections.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.6 STARTUP AND SYSTEMS COMMISSIONING

A. Comply with requirements for startup and system commissioning specified in Section 260923 "Lighting Control Systems and Devices."

B. CLEANING

1. Thoroughly clean each installed luminaire within one month of substantial completion.

END OF SECTION 265100

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.3 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. SBB: Secondary bonding busbar.

C. PBB: Primary bonding busbar.

D. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Result of the ground-resistance test, measured at the point of BCT connection.
b. Result of the bonding-resistance test at each SBB and its nearest grounding electrode.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607.

2.2 CONDUCTORS

A. Comply with UL 486A-486B.

B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

C. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

C. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

D. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. PBB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as PBB and shall comply with TIA-607.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

B. SBB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the SBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

2. The bonding conductors between the PBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

C. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

D. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.
4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a SBB.

3.4 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.5 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the PBB with insulated bonding conductor.

E. Interconnections: Interconnect all SBBs with the PBB with the telecommunications backbone conductor. If more than one PBB is installed, interconnect PBBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the SBB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each SBB and PBB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each SBB to the ground bar of the panelboard.

I. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

J. Access Floors: Bond all metal parts of access floors to the SBB.

3.6 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label PBB(s) with "fs-PBB," where "fs" is the telecommunications space identifier for the space containing the PBB.
2. Label SBB(s) with "fs-SBB," where "fs" is the telecommunications space identifier for the space containing the SBB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a PBB and a SBB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

    a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the PBB and in each SBB. Maximum acceptable ac current level is 1 A.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 270526

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Metallic surface pathways.
7. Nonmetallic surface pathways.
8. Tele-power poles.
9. Hooks.
10. Boxes, enclosures, and cabinets.
11. Polymer-concrete handholes and boxes for exterior underground cabling.
12. Fiberglass handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

A. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product data for the following:

1. Surface pathways
2. Wireways and fittings.
3. Tele-power poles.
4. Boxes, enclosures, and cabinets.
5. Underground handholes and boxes.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
3. Underground ducts, piping, and structures in location of underground enclosures and handholes.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Data: Provide seismic bracing for all pathway racks, enclosures, cabinets, equipment racks, and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT:

a. Material: Steel or die cast.
b. Type: compression.

2. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.

G. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum, riser or general-use installation unless otherwise indicated.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569.

2.3 HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569.

D. Galvanized steel.

E. J shape.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep
5. Gangable boxes are prohibited.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

G. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
5. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
6. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.

B. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.

C. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.

D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

E. Install surface pathways only where indicated on Drawings.

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569.
4. NECA 101
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

D. Complete pathway installation before starting conductor installation.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

G. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

K. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

M. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

O. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

P. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

Q. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

R. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

S. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

T. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

U. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

V. Expansion-Joint Fittings:

1. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg Ftemperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

W. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power, and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet o.c.
5. Provide a hook at each change in direction.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

SECTION 270532 - COMMUNICATIONS EQUIPMENT AND CABLING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section defines the requirements for the provision and installation of a complete Communications Cabling System (CCS), including cable and termination hardware, equipment racks and associated rack equipment, inner-duct and cable support hardware, which provides for a Category 6 voice and data transmission infrastructure throughout the facility.

1.2 REFERENCES AND COMPLIANCES TO THE LATEST EDITIONS, AS RELATED

A. Design, install and test a Communications Cabling System (CCS) per manufacture's requirements and in accordance with NFPA-70 (National Electric Code), state codes, local codes, requirements of authorities having jurisdiction, and particularly the following standards:

1. General.
2. National Electrical Code (NEC).
3. National Electrical Safety Code (NESC).
4. Occupational Safety and Health Act (OSHA).

B. Communications:

1. ANSI/TIA/EIA-455: Fiber Optic Test Standards.
2. ANSI/TIA/EIA-526: Optical Fiber Systems Test Procedures.
3. ANSI/TIA/EIA-568-C: Commercial Building Telecommunications Cabling Standard.
4. ANSI/TIA/EIA-569: Commercial Building Standard for Telecommunication Pathways and Spaces.
5. ANSI/TIA/EIA-606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
6. ANSI/TIA/EIA-607: Commercial Building Grounding and Bonding Requirements for Telecommunications.
7. ANSI/TIA/EIA -TSB67: Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems.
8. ANSI/TIA/EIA -TSB75: Additional Horizontal Cabling Practices for Open Offices.
9. IEEE 802.3 (series): Local Area Network Ethernet Standard, including the IEEE 802.3z Gigabit Ethernet Standard.
10. ISO/IEC IS 11801-ADM2: Generic Cabling for Customer Premises.
11. BICSI: BICSI Telecommunications Cabling Installation Manual (TCIM).
12. BICSI: BICSI Telecommunications Distribution Methods Manual (TDMM).

1.3 SYSTEM DESCRIPTION

A. Provide a fully functional communications system, which includes:

1. Furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete ANSI/TIA/EIA and ISO/IEC compliant communications system as hereinafter specified and/or shown on the Contract Documents.
2. Build-out of all communications areas, floor distribution and data/telecommunication outlets meeting the requirements of ANSI/TIA/EIA 568-C.1, C.2 and C.3.
3. Coordination of the entire installation with all other divisions.

B. Systems Summary

1. Vandelay utilizes a Structured Cabling System comprised of Work Areas, Horizontal Cabling, MDF, IDF, Backbone and Campus Distribution Cabling) and Entrance Facilities.
2. Vandelay Structured Cabling System is managed as a utility independent of the applications and systems supported including voice communications, data communications, baseband, and broadband video communications, wireless, building automation systems and departmental systems.

1.4 DEFINITIONS AND ABBREVIATIONS

A. ANSI – American National Standards Institute.

B. AWG – American Wire Gauge.

C. BICSI – Building Industry Consulting Service International.

D. CMP – Communications Multi-conductor Plenum Cable.

E. CMR – Communications Multi-conductor Riser Cable.

F. EIA – Electronics Industry Alliance.

G. FBC – Furnished by Contractor.

H. FBO – Furnished by Owner.

I. HC – Horizontal Cross connect.

J. IBC – Installed by Contractor.

K. IBO – Installed by Owner.

L. IDC – Insulation Displacement Connector.

M. IDF- Intermediate Distribution Frame (same as TR).

N. IC – Intermediate Cross connect.

O. LSPM – Light Source and Power Meter.

P. MC – Main Cross connect.

Q. MDF- Main Distribution Frame.

R. MPOP – Main Point of Presence.

S. NFPA – National Fire Protection Agency.

T. OFCP – Optical Fiber Conductive Plenum.

U. OFCR – Optical Fiber Conductive Riser.

V. OFNR – Optical Fiber Nonconductive Riser.

W. OLTS – Optical Loss Test Set.

X. OM4 – Optical Fiber Multimode.

Y. OS1- Optical Fiber Single mode.

Z. OS2 – Optical Fiber Single mode.

AA. OTDR – Optical Time Domain Reflectometer.

BB. POP – Point of Presence.

CC. RU – Rack Unit.

DD. DMM – Telecommunications Distribution Methods Manual.

EE. TIA – Telecommunications Industry Association.

FF. UL – Underwriters Laboratory.

GG. UTP – Unshielded Twisted Pair.

HH. WAP – Wireless Access Point.

II. Backbone – The inter-building and intra-building cabling and connecting hardware, including pathway, that provide interconnections between entrance facilities, MDF and IDF.

JJ. Building Backbone Cabling – The inter-building cabling and connecting hardware that provides interconnections between the building entrance facility, MDF and IDF. Referred to also as Riser Cabling.

KK. Campus Backbone Cabling – The intra-building cabling and connecting hardware that provides interconnections between buildings and facilities, e.g. Wire Centers. Referred to also as Feeder Cabling.

LL. Furnish – To supply or make available for use.

MM. Horizontal Cabling – The cabling between and including the work area outlet, wiring block and horizontal cross-connect/patch panel in the telecommunications room. Referred to also as Station Cabling.

NN. Horizontal Cross-connect (HC) – Provides interconnection between the Horizontal Cabling and the Building Backbone Cabling or equipment in the Telecommunications Room through Host Cabling.

OO. Host Cabling – Located in the Telecommunications Rooms, connects to equipment and provides interconnection to Horizontal Cabling through Horizontal Cross-connect.

PP. Install – Operations including anchoring, applying, assembly, cleaning, erection, finishing, protecting, unloading, unpacking and similar operations.

QQ. Intermediate Cross-connect (IC) – Provides interconnection between Wire Center and MDF, Wire Center and the Building Backbone Cabling, or MDF to the Building Backbone Cabling.

RR. Ladder Cable Tray – A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

SS. Main Cross-connect (MC) – Normally located in the MDF, provides interconnection between core equipment and building through Building Backbone Cabling.

TT. Provide – To furnish and install or to make ready for the intended use and in complete operating condition.

UU. Wall Spline Cable Tray – A fabricated structure consisting of a single longitudinal side rail with individual transverse members (rungs). Referred to also as Finger Tray.

VV. Wire Mesh Cable Tray – A fabricated structure consisting of wire mesh bottom and side rails. Referred to also as Basket Tray.

1.5 DESIGN REQUIREMENTS

A. The intent of the Project Drawings and Specifications is to include all items necessary for the proper execution and completion of the Work.

B. The Project Drawings and Specifications are complementary, and what is required by any one shall be as binding as if required by both.

C. It is the ultimate responsibility of the Contractor to supply all parts and materials necessary to assure a complete and efficient communications system as designed.

1.6 RECORD DOCUMENTS

A. Prepare record documents in accordance with the specifications.

1.7 SUBMITTALS

A. Product Data Submittals:

B. Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.

1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
2. For those items noted as allowing “or equal,” and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other descriptive information, along with a written description detailing the reason for the substitution.
3. Provide standard manufacturer’s cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. Submit a cable routing and grouping plan as follows:

    a. Where the cable routing and grouping is to be provided as shown on the Contract Documents, do not provide a cable routing and grouping plan. Submit written documentation stating that the cable routing and grouping will be provided as shown on the Contract Documents.
    b. Where changes in cable routing and grouping are proposed, submit complete floor plan(s) and/or detail drawing(s) showing the proposed routing, raceway sizes and locations, and cabling in a manner equal to that of the Contract Documents.

4. Submit wall field and rack elevations as follows:

    a. Where changes to the wall field termination blocks and wire management are proposed, submit wall field termination block and wire management elevations along with written documentation detailing the reason for the change. The change request must be approved in writing by the Engineer/Designer prior to proceeding with the change.

5. Submit a list of proposed test equipment for use in verifying the installation of the CCS. Proposed test equipment shall meet the criteria as stated in PART 3 – TESTING.

    a. Submit for each testing device:

        1) Manufacturer and product number.
        2) Documentation from the manufacturer showing date and outcome of last re-calibration. Testing device shall have been re-calibrated within the manufacturer’s recommended calibration period, encompassing the period of time when the testing device will be used on this project.
        3) Documentation from the manufacturer showing software revision. Software revision shall be most current revision available for the device and shall be based upon the most current ANSI/TIA/EIA testing guidelines.

b. Submit proposed copper and fiber cable test forms (see PART 3 – TESTING for more detail).

6. Submit a list of the personnel who will be assigned to the project, the type of work they will be performing per QUALITY ASSURANCE below, copies of the manufacturer's training certification for each, and copies of BICSI or equivalent CCS training certifications. If personnel changes are made during the project, submit the above information for any new personnel prior to their commencement of work on the project.

C. Closeout Submittals:

1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to the Engineer/Designer in the communications-specific O&M Manual for Communications binder labeled with the project name and description.
2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications, and spreadsheets, including maintenance hole/hand-hole butterfly drawings.

a. Portions of the text below may be contained in other Sections (e.g., 26 00 10 (or equivalent) - General Electrical). Coordinate text for accuracy and content.
b. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
c. Keep Record Drawings at the job site and make available to the Owner and Engineer/Designer at any time.
d. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
e. Show identifiers for major infrastructure components on Record Drawings.
f. Provide a table/schedule showing the following information for each cable link in the project on the Record Drawings. Include the following items in the table/schedule:

1) End locations of cable (telecommunications room).
2) Link Type (campus, riser, horizontal).
3) Media type (fiber, Cat 6, Cat 3, etc.).
4) Cable Identifier.
5) Actual measured link length (from test results).
6) For fiber optic cabling, as-designed maximum link attenuation at design frequency (indicating frequency used for design calculations) including as-designed maximum splice loss and as-designed maximum connector loss.
7) For fiber optic cabling, actual measured link attenuation as tested with test frequency (from test results).

1.8 QUALITY ASSURANCE

A. Approved Manufacturers: The selected manufacturer for the Structured Cable System, including optical fiber and all termination equipment, shall be from a manufacture that has a minimum of three (3) years' experience in producing the types of systems and equipment specified.

B. Contractor Qualifications: The contractor shall be a company specializing in installation of Communications Cabling Systems (CCS) and have meet all the requirements set forth by the manufacturer as a Certified Installer prior to submission of bids and proposals to the Contracting Officer. The telecommunications installation contractor shall not be a certified electrical contractor installing the CCS system.

C. List of references: Prior to bidding, submit:

1. References for no less than five similar projects (in terms of size and construction cost) performed by the Contractor under the Contractor's current business name within the past three years. Detail the following for each project:

   a. Project name and location.
   b. Construction cost.
   c. Supply a brief description of the project, the components involved, and the CCS manufacturer used on the project.
   d. Number of station drops.
   e. Customer contact names, phone numbers, and addresses.
   f. Manufacturer's certification document.

D. The contractor shall also be held responsible for the following:

1. Material and equipment shall be new, and conform to grade, quality, and standards specified. Equipment and materials of the same type shall be a product of the same manufacturer throughout.
2. Equipment and materials of the type for which there are independent standard testing requirements, listings, and labels, shall be listed and labeled by the independent testing laboratory.
3. All communications installations shall be installed by BICSI Certified Installation Teams.
4. Subcontractors shall be pre-qualified and shall assume all rights and obligations toward the contractor that the contractor assumes toward the owner and engineer/designer.

1.9 WARRANTY

A. The CCS Contractor shall provide a Certified Warranty on the cabling system channel warranty covering all parts, labor, and performance to all applied standards for a period of not less than one (1) year from the date of substantial completion or certificate of occupancy whichever is later. The system's warranty shall include all internal and external fiber, as well as all voice and data cabling and termination hardware to the appropriate category. The contractor shall furnish the manufacturer's warranty certificate to the Contracting Officer within thirty (30) days of acceptance.

B. Manufacturer's Warranty

1. Provide a CCS Manufacturer extended product, performance, application, and labor warranty that shall warrant all passive components used in the CCS. Additionally, this warranty shall cover components not manufactured by the CCS Manufacturer but approved by the SCS Manufacturer for use in the CCS (i.e., "Approved Alternative Products"). The CCS Manufacturer warranty shall warrant:

a. That the products will be free from manufacturing defects in materials and workmanship.
b. That the cabling products of the installed system shall exceed the specification of ANSI/TIA/EIA 568-C and exceed ISO/IEC 11801 standards.
c. That the installation shall exceed the specification of ANSI/TIA/EIA 568-C and exceed ISO/IEC 11801 standards.
d. That the system shall be application independent and shall support both current and future applications that use the ANSI/TIA/EIA 568-B and ISO/IEC 11801 component and link/channel specifications for cabling.

C. The CCS contractor shall provide permanent link test results while providing a full channel warranty.

D. Installation personnel shall meet manufacturer's training and education requirements for implementation of extended warranty program.

E. The CCS contractor shall agree to repair or replace defective components/materials and correct defective work when given notice by Owner during the warranty period.

F. Damage caused to completed work, shall be replaced, or repaired by the contractor. Effect replacement or substitutions of equipment within 24 hours upon receipt of warranty request from Owner during normal working hours.

G. The warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrently with, and not limiting, other rights and warranties the Owner may have under provisions of the Contract Documents

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers: The selected manufacturer for the Structured Cable System, including optical fiber and all termination equipment, shall be a Certified Cabling System Solution

B. CCS components shall be manufactured by a single manufacturer. Components shall not be intermixed between different manufacturers unless the manufacturer of the SCS has listed (in writing) another manufacturer's component as an "Approved Alternative Product" and will warrant the "Approved Alternative Product" as part of the CCS Manufacturer Warranty.

2.2 PRODUCTS

A. Cable and Fiber Coloring Standard

1. Description:

a. ANSI/TIA-568-C.2 Standard Compliant.

b. Category 6, 4-Pair, 22-26 AWG, 100-Ohm Characteristic Impedance, Solid UTP.

1) Berk-Tek.

c. Category 6A, 4-Pair, 22-26 AWG, 100-Ohm Characteristic Impedance, Solid UTP.

1) Berk-Tek.

d. UL94 Flammability Rating.

2.3 TERMINATION HARDWARE

A. Active Equipment Installation

1. MDF/IDF All active equipment (Server, Storage, Routers, Switches, etc.) will be procured and installed by contractor with the exception of OFCI identified in on T2.02 and in section 016400. OFCI equipment shall be programmed by owner after installation.

B. Rack mounted Power Distribution Units for the MDF/IDF procured and installed by contractor.

C. Wireless Access System Components

1. Install an extra 20’ of Category 6A cable per WAP for relocation as needed for optimal coverage and to make the system fully functional.
2. Final placement testing will be required by contactor to ensure proper wireless coverage, WAP quantities and placement once the building reaches substantial completions and prior to occupancy.
3. Wireless access points to be OFCI.

2.4 RACEWAYS

A. All communications conduit raceway shall be a minimum of 1 IN EMT home run from the communications outlet to within 1 FT of the cable management systems (tray or J-hook) in accessible ceiling space.

1. Conduit installed to cable tray in hard ceiling spaces will be unacceptable.

2.5 EQUIPMENT RACKS AND MOUNTING HARDWARE

A. Two-Post Equipment Racks:

1. Materials:

a. 1-7/12 x 7-foot aluminum relay equipment rack meeting EIA standard E-310-D with all floor anchors and bolts.
b. Black anodized finish on rack.

c. Two (2) 6-inch (152 mm) rack rails with EIA-310-D universal 5/8 - 5/8 - 1/2 inch (16 - 16 - 13 mm) alternating hole patterns, and Rack-Mounting Unit markings. Holes tapped for #12-24 screws with roll-formed threads.
d. Rack line up spacers.
e. Fifty (50) pilot point #12-24 bonding screws with combination Phillips/Straight heads per rack.
f. One-hole ground clamps as required.
g. Vertical Cable Manager for Carrier Patch Racks.

2. Manufacturer / Model Nos.:

a. Chatsworth Products, Inc.: 46053-705.

3. Accessories:

a. Vertical Cable Manager (width as indicated on drawings):
b. Double-sided, with hinged door and cable guides in front, and hinged bar closures in back.
c. Dimensions: (As Required) 3.64W x 14.6 x 84 H inch (92.7W x 371D x 2134H mm).
d. Color: Black.
e. Manufacturer / Model No.:

1) Chatsworth Products, Inc.: 32621-705.

4. Horizontal Cable Manager:

a. CPI / 35441-702

5. Fiber Management Spools:

a. CPI / 40100-703

6. Floor Anchor Kit:

a. CPI / 40604-001
b. Panduit / RFAKIT

7. Vertical Cable Manager:

a. Rack End: Panduit / PR2VD08
b. Between Racks: Panduit / PR2VD128

2.6 EQUIPMENT CABINETS

A. Materials

1. 29.53W x 42.98D x 88.89 inch overall, (48) rack spaces, aluminum construction, custom manufactured for Owner with seismic bracing option and frame couplers as required.

2. Black powder coat finish.
3. Two (2) mounting rails with EIA-310-E universal 5/8 - 5/8 - 1/2 inch (16 - 16 -13 mm) alternating hole patterns, Rack-Mounting Unit markings, and M6 caged nuts, bolts, cup washers, and insertion tool.
4. Cable access roof.
5. Bonding clamps as required.
6. Static weight capacity: 3,000 lb (1362 kg).

B. Manufacturer / Model No.:

1. APC Netshelter SX / AR3157

C. Bonding Screws:

1. Remove the paint from equipment being installed and the rack or cabinet.
2. Manufacturer: Panduit. Submit part(s) for approval.

PART 3 - EXECUTION

3.1 CABLE RUNWAYS

A. Install tubular steel construction cable runway, designed for overhead cable support between wall and equipment rack as shown on Drawings.

1. Supply all necessary hardware to transition around columns or doorways.

B. Tubular steel construction, designed for overhead cable support between wall and equipment rack.

1. Supply all necessary hardware to transition around columns or doorways.

C. Provide all necessary support devices for cable runway including but not limited to:

1. Triangle wall supports.
2. Wall angle supports.
3. Junction and straight splice kits.
4. Rack to runway mounting kits.
5. Cable radius drop.

3.2 PATHWAYS AND SPACES

A. All cable routing shall comply with ANSI/TIA/EIA 569-A Commercial Building Telecommunications Pathways and Spaces.

3.3 CABLE SUPPORT

A. In the absence of conduit, J-hooks or other system warranty compliant support devices designed for the application shall be used to support the cable. Provide cable support at the lesser distance

of not greater than 48" on center, or not to exceed cable manufacturer's recommendations. All devices will attach to the building structure in accordance with the device manufacturers recommendations. All cable runs shall be separated by color through the support devices. Where drawings specifically allow the installation of cable in void, plenum or suspended ceiling areas, the contractor shall provide support for all wire and cable.

B. Contractor shall not place on or attach cable directly to items such as T-bar grid, concealed spline grid, flexible or rigid ductwork, HVAC registers, sprinkler piping or fixtures, electrical conduit, light fixtures, or any other unacceptable support structures.

1. CABLE SUPPORT HARDWARE – Erico, B-Line or Approved Equal

a. Ceiling Space - Erico/Caddy

1) J-Hook, 4-Bundle Trees (Red/White/Blue/Misc)

a) 235-cables/side CAT300 CMLN w/CATTBCM
b) 185-cables/side CAT64 2D
c) 50-cables/side CAT32 2D
d) 32-cablesside CAT21 2D

b. Hook and Loop Wrap Ties (Black-Plenum) - Bulk rolls

3.4 REQUIREMENTS

A. MDF/IDF

1. Provide and install on the walls, 4 FT x 8 FT 3/4 IN thick, AC-grade, void-free plywood backboards with two coats of fire-retardant gray paint in both MDF and IDF.

a. Backboards must be securely fastened no greater than 1 FT above the finished floor to support the attached equipment.

2. Connect and interconnect in both MDF and IDF:

a. Telecommunication grounding busbar (TGB).

B. Horizontal Cable Management:

1. Horizontal cable management shall be rack mounted above and below all Fiber patch panels and "AS NEEDED" for Category 6 patch panels supplied and installed by the Contractor.

3.5 INSTALLATION CRITERIA

A. Telecom/Data Outlets: Provide as follows:

1. Standard Tele/Data outlets consisting of Vandelay Color Standard CAT 6 cables per drawing.

a. Provide and install outlets as shown on drawings.

B. Copper Cabling

1. Provide and install specified copper cabling as shown on the drawings and required by the specifications.
2. Install horizontal cabling as indicated on drawings and required by the specifications between the MDF/IDF and the telecommunications outlet assemblies at workstations.

3.6 INSTALLATION

A. Examine pathway elements intended for cable. Check conduit raceways, wall and floor sleeves, pull boxes, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. All metallic conduits and sleeves shall be provided with bushings prior to installation of cables. Proceed with installation only after unsatisfactory conditions have been corrected.

B. In telecommunications spaces, cables shall be routed as close as possible to ceiling maintaining a 3” clearance to ceiling, floor, or corners to ensure that adequate wall or backboard space is available for current and future equipment and cable terminations. Cables shall not be attached.

C. to existing pipes, conduits, ducts, or other mechanical structures and supports. Minimum bend radius shall be observed.

D. Dress and attach cables to the backboard along the shortest possible route running horizontally and vertically square to the backboard. Bundle similarly routed cables together and attach by means of clamps or distribution rings. Cable dress and attachment shall minimize obstruction to future installations of cable, equipment, and backboards.

E. Pulling lubricants – to maintain Cat 6 performance utilize only lubricants specifically designed for data communication cables. The use of other lubricants can degrade the performance time of the cabling and increase insertion loss over time. Any cabling installed with non-specific data cabling lubricant will be replaced by the Contractor at no cost to the Owner.

F. All cables shall be marked at all junction boxes, pull boxes, cabinets, boxes and terminations. Each cable run between terminating locations shall be one continuous cable without splices.

G. Inspect all conduit bends to verify proper radius. Comply with code for minimum permissible radius and maximum permissible length before insertion of pull stations.

H. Every cable run shall be a continuous single cable, homogenous in nature. Splices are not permitted anywhere. At no time shall a horizontal run exceed 90 meters (295 feet).

I. Backbone cables shall be grouped separately from horizontal distribution cables. Cable for other systems shall be grouped separately from cables for telephone and data.

J. No exposed wiring shall be permitted.

K. When terminating a horizontal cable, the integrity of the twist for each individual pair shall be maintained up to the point of termination, not to exceed ½ inch. Remove only the amount of sheath necessary to make the termination.

L. Minimum bend radius and maximum pulling tension and sidewall pressure for all cables shall be maintained during and after installation. Cables shall be installed in strict accordance with these specifications and manufacturer's recommendations.

M. Any damage to Owner's existing cabling or existing cable owned by others, caused as a result of work performed under this scope, shall be brought to the attention of Owner's Representative and repaired or replaced by this Contractor in the agreed amount of time.

N. Penetrations through floor and fire-rated walls shall utilize approved fire stop assemblies, and be fire stopped after installation and testing; utilizing a UL approved fire stopping system approved for that application.

O. Where drawings specifically allow the installation of cable in void, plenum or suspended ceiling areas, the contractor shall conform to ANSI/TIA/EIA 569-A with respect to the separation from power and EMI sources.

P. All UTP cable runs shall be neat and consistent bundles running within corridors and cable trays where possible, without twists or loops, above common areas branching off as needed to serve offices and professional areas. Physical star cabling methodologies are unacceptable.

Q. Velcro cable tie all cables and cut to length at termination point. Groom (comb) all exposed cable bundles. Velcro cable ties shall be plenum rated in appropriate spaces. All Velcro cable ties shall be "bulk" type, cut to length, and shall maintain one complete over-wrap of the circumference of the bundle.

R. Comply with ANSI/J-STD-607-A-2002 for all grounding and bonding of the entire system.

S. Fire Stopping: Comply with ANSI/TIA/EIA and NEC. Attach label and or drawing indicating UL system number at each penetration requiring greater than one (1) hour fire stopping rating.

T. Leave 12" of Cat 6 cable slack protruding from outlet mounting point and protect from damage by workmen prior to installing outlet.

U. Leave five (5) meters service loops attached neatly to plywood backboard utilizing D-rings in all fiber optic cable runs.

V. Cable terminations at all locations shall be dressed neatly, orderly and display quality workmanship.

W. Minimize removal of cable insulation jacket at all riser cable terminations.

X. Wall outlet jack colors shall be consistent with cable jacket.

Y. All cables shall terminate in the appropriate rack as indicated on drawings.

Z. Patch panel jack colors shall be consistent with cable jacket.

3.7 GROUNDING

A. Grounding

1. Provide grounding and bonding per specifications.

3.8 TESTING

A. The cabling system will be tested for compliance with ANSI/TIA/EIA 568 C.2 Category 6 performance requirements.

1. Testing shall be accomplished using level II or higher field tester.
2. Submit all test results on both PDF via thumb drive, and hard copy, no later than ten days after the cables are tested.
3. All failures shall be remedied and retested. “Failed” or “Passed” data test results are unacceptable.
4. Unshielded Twisted Pair (UTP)
5. General

a. Testing shall be performed on each Permanent Link.
b. Testing shall conform to ANSI/TIA-568-C.2-10.
c. Each cable shall be tested for continuity including opens, shorts, grounds and polarity. Correct all opens, shorts, grounds, and pair reversals.
d. Test each cable and all connecting hardware with a Level III minimum accuracy cable analyzer per ANSI/TIA-1152.
e. Test reports shall be provided to the Owner in electronic format at the time of project close out and include any special software required to read the test results.

1) Test reports shall include the following information for each cable, all pairs, or pair combinations:
2) Test Date
3) Building
4) Cable Number
5) Wire Map

a) Open and Short Testing
b) Polarity Testing
c) Pair Transposition Testing

6) Length
7) Electrical Parameters
8) Insertion Loss
9) NEXT
10) PSNEXT
11) Return Loss
12) ACRF / ELFEXT
13) PSACRF / PSELFEXT
14) Propagation Delay
15) Delay Skew

3.9 FOR REFERENCE

Table 1. TIA/EIA Internal Channel Test Limits Over Category 6 and 6A Cabling

Parameter	Category 6 (568-B.2-1)	Category 6 (TSB-155)	Category 6A (568-B.2-10)
Data Rate	1000BASE-T	10GBASE-T	10GBASE-T
Frequency Range	1-250 MHz	1-500 MHz	1-500 MHz
Length	100m	37m*	100m
Propagation Delay	548 ns @ 100 MHz 546 ns @ 250 MHz	548 ns @ 100 MHz 546 ns @ 250 MHz Not specified @ 500 MHz	538 ns @ 100 MHz 536 ns @ 250 MHz 536 ns @ 500 MHz
Delay Skew	50 ns	50 ns	50 ns
Insertion Loss	21.3 dB @ 100 MHz 35.9 dB @ 250 MHz	21.3 dB @ 100 MHz 35.9 dB @ 250 MHz 53.4 dB @ 500 MHz	20.9 dB @ 100 MHz 33.9 dB @ 250 MHz 49.3 dB @ 500 MHz
Return Loss	18.6 dB @ 100 MHz 8.0 dB @ 250 MHz	12.0 dB @ 100 MHz 8.0 dB @ 250 MHz 6.0 dB @ 500 MHz	12.0 dB @ 100 MHz 8.0 dB @ 250 MHz 6.0 dB @ 500 MHz
NEXT	39.9 dB @ 100 MHz 33.1 dB @ 250 MHz	39.9 dB @ 100 MHz 33.1 dB @ 250 MHz 22.0 dB @ 500 MHz	39.9 dB @ 100 MHz 33.1 dB @ 250 MHz 26.1 dB @ 500 MHz
PSNEXT	37.1 dB @ 100 MHz 30.2 dB @ 250 MHz	37.1 dB @ 100 MHz 30.2 dB @ 250 MHz 20.4 dB @ 500 MHz	37.1 dB @ 100 MHz 30.2 dB @ 250 MHz 23.2 dB @ 500 MHz
ACRF (ELFEXT)	23.3 dB @ 100 MHz 15.3 dB @ 250 MHz	23.3 dB @ 100 MHz 15.3 dB @ 250 MHz 9.3 dB @ 500 MHz	23.3 dB @ 100 MHz 15.3 dB @ 250 MHz 9.3 dB @ 500 MHz
PSACRF (PSELFEXT)	20.2 dB @ 100 MHz 12.3 dB @ 250 MHz	20.2 dB @ 100 MHz 12.3 dB @ 250 MHz 6.3 dB @ 500 MHz	20.2 dB @ 100 MHz 12.3 dB @ 250 MHz 6.3 dB @ 500 MHz

*TSB-155 states that 10GBASE-T should operate over channel lengths up to 37m over Category 6 cabling; channel length may be extended up to 55m depending on the alien crosstalk environment, and beyond 55m with AXT mitigation techniques.

A. The Contractor shall provide permanent link test results, while providing a full channel warranty.

B. If copper backbone cable contains more than one (1) percent bad pairs, remove and replace entire cable.

C. All cables shall be tested for DC continuity of each conductor.

D. Shorts, crosses and grounds between conductors and shields will be corrected and retested.

E. Submit test results as specified above.

F. The single mode fiber optic cable shall have a maximum attenuation of .70dB/km for inside plant cable and 0.50 dB/km for outside plant.

G. Bi-directional testing of optical fibers is required.

3.10 CLEANING

A. After completing system installation, including outlet fittings and devices, clean, inspect exposed finish.

3.11 CABLING ADMINISTRATION/ LABELING DOCUMENTATION

A. Provide cable identification tags and system labeling on all riser cables according to Class 3-Campus of the BICSI/ ANSI/TIA/EIA 606A & TDMM documents. Consult with Owner's telecom representative on schema prior to making labels.

B. Class 3 administration addresses the needs of a campus, including its buildings and OSP elements. In addition, identifiers for buildings and campus cabling are included. Administration of building pathways and spaces and OSP elements is recommended.

1. Minimum Description of Identifier needed for structured cabling administration.

a. Campus.
b. Building.
c. Floor.
d. Telecommunications space (IDF, MDF, AV, etc.).
e. Cabinet, rack, enclosure, or wall mounted unit.
f. Patch panels.
g. Port within the patch panel.
h. User horizontal drop location.
i. Horizontal link.

C. All IDF/MDF room labeling shall be machine generated utilizing computer generated labels.

D. Label each outlet with permanent, fitted labels to meet cable labeling standard.

1. Consult with OWNER telecom representative on schema prior to making labels.

E. Furnish owner will a detailed and complete document showing all cabling routes, terminations labeling and testing results at substantial completion in both hard and soft copy (PDF via thumb drive) formats.

3.12 OPERATION TRAINING AND MAINTENANCE DATA

A. Demonstrate to the Owner's designated representatives, Contractor, Architect, and representatives of the authorities having jurisdiction, the features and functions of the system and subsystems including labeling process.

B. Furnish the necessary trained personnel to perform the demonstration and instructions and arrange to have the manufacturer's representatives present to assist with the demonstrations.

C. Arrange with the Owner's designated representative the date and times for performing the demonstrations.

END OF SECTION 270532

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ladder cable trays.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Allied Tube & Conduit; a Tyco International Ltd. Co.
2. Chalfant Manufacturing Company.
3. Cooper B-Line, Inc.
4. MP Husky.

B. Description:

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 9 incheso.c.
3. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.

6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
7. Minimum Usable Load Depth: 4 inches.
8. Straight Section Lengths: 10 feetexcept where shorter lengths are required to facilitate tray assembly.
9. Width: 18 inches unless otherwise indicated on Drawings.
10. Fitting Minimum Radius: 24 inches.
11. Class Designation: Comply with NEMA VE 1, Class 12B.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316.
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.4 MATERIALS AND FINISHES

A. Aluminum:

1. Materials: Alloy 6063-T6 according to ANSI H 35.1/H 35.1M for extruded components and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H 35.1/H 35.1M for fabricated parts.
2. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
3. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593, and ASTM F 594.

2.5 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Covers: Solid type made of same materials and with same finishes as cable tray.

C. Barrier Strips: Same materials and finishes as for cable tray.

D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

A. Lettering: 1-1/2-inch-high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure and install seismic restraints.

G. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

I. Support bus assembly to prevent twisting from eccentric loading.

J. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

K. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

L. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

M. Make changes in direction and elevation using manufacturer's recommended fittings.

N. Make cable tray connections using manufacturer's recommended fittings.

O. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

P. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

Q. Install cable trays with enough workspace to permit access for installing cables.

R. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

S. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

T. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

U. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.
f.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall, so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 270544

SECTION 270553 - LABELS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE DOCUMENTS

A. Owner's Data Center Network Cable Labeling Scheme

1.2 SUBMITTALS

A. See Section 013300 - Administrative Requirements, for submittal procedures.

B. Submit samples of each label type specified herein, including:

1. Communications conduit label.
2. Rack and cabinet label.
3. Ground bar label.
4. Patch bay and patch panel label.
5. Termination block label.
6. Technology outlet label.
7. Cable label.
8. Patch cord label.
9. Fiber optic jumper label.

PART 2 - PRODUCTS

2.1 LABEL AND SIGNAGE ENGRAVING PLASTIC

A. Plastic engraving material possessing the following specifications and characteristics:

1. XT/ABS two-layer material.
2. 0.010-inch (0.25 mm) cap layer over base layer.
3. Engraving depth: 0.012 - 0.014 inch (0.3 - 0.36 mm).
4. 1/16 inch (1.6 mm) thick for rack, rack frame, cabinet, and panel labels.
5. 3/32 inch (2.4 mm) thick for area over head signage.
6. Standard color: azure blue over white.
7. Warning color: red over white.
8. Matte Finish.

B. Manufacturer / Material:

1. Gravograph: 1/16-inch (1.6 mm) blue: New Hermes, Gravoply Decor #17396.
2. Gravograph: 1/16-inch (1.6 mm) red: New Hermes, Gravoply Decor #17385.
3. Gravograph: 3/32-inch (2.4 mm) blue: New Hermes, Gravoply Decor #17489.

2.2 LABEL TAPE

A. Various tapes with the following specifications and characteristics:

1. Vinyl B-439 1/2-inch (12.7 mm) W x 50 foot (15.24 meter), continuous.
2. White characters over black background.
3. Black characters over white background.
4. Black characters over gray background.

B. Manufacturer / Materials:

1. Typical: Brady / PTL-8-430.

2.3 CABLE OVERWRAP LABELS

A. Various wraps with the following specifications and characteristics:

1. Low smoke self-laminating TEDLAR B-642 material.
2. Black characters over white background.
3. Various lengths and widths.
4. Plenum rated.

B. Manufacturer / Materials:

1. Typical: Brady / PTL-19-642.

2.4 FIBER OPTIC STRAND LABELS

A. Various wraps with the following specifications and characteristics:

1. Polyolefin B-425 material.
2. Black characters over white background.
3. Fold over sticky tab for attachment.

B. Manufacturer / Materials:

1. Typical: Brady / PTLFP-01-425.

PART 3 - EXECUTION

3.1 GENERAL

A. All labels shall be installed plumb and square. Contractor shall make sure to use “clean hands” when installing the labels to avoid fingerprints and smudges. Labels installed out-of-square or that are dirty shall be replaced.

B. Legibly label all cables, cords, cabinets, rack frames, racks, patch bays, patch shelves, patch panels, termination frames, termination blocks, and technology outlets that have not already been labeled. Consult the Owner's Representative and Designer for specific directions (e.g. colors) that may supplement the information contained herein.

C. Labeling on the actual cable, apparatus, places, rooms, etc., may have some of the fields listed in the Universal Labeling Schema "hidden" at the discretion of the Owner's Representative and Designer. The complete label will appear in all databases and lists.

D. Follow the Owner's naming convention, as described in Owner's Naming OPR.

3.2 RACK (TWO-POST AND FOUR-POST)

A. All racks and frames shall be labeled. Labels shall be applied on both the front and rear faces of the units.

B. Furnish and install engraved plastic labels for all racks and frames.

C. Use double sided foam backed tape to mount the labels at the top of the units. Place label on each unit where directed by Owner's Representative.

3.3 TERMINATION COMPONENT LABELING

A. Furnish and install labels on all faceplates, jack / coupler / barrel modules, patch panels, shelves, patch bays, and equipment.

B. The overall patch panel or bay labels shall be engraved plastic labels. These may be applied to the patch bay doors or to an adjacent horizontal wire manager cover at the discretion of the Designer or Owner's Representative. In general, patch panels do not have sufficient space for engraved labels so an adjacent wire manager cover will be used.

C. Label content shall be alpha-numeric as noted on the Drawings. Characters shall be 1/4 inch (6.35 mm) high, Arial or Helvetica font.

D. Jacks, couplers, modules, groupings, etc. shall be labeled with label tape. Note that when an adjacent wire manager is used to carry the engraved label a miniature version of the label shall be applied to the actual panel or bay using label tape.

E. Labels shall be numbered according to the project labeling schema. The scheme shall include to-from information for all tie and riser cable ports including the building identifier, floor identifier, and room identifier. The outlet port label scheme shall include the building identifier, floor identifier, outlet identifier, and jack / coupler module identifier.

3.4 GROUND BAR LABELING

A. Affix a red engraved plastic label to all communications ground bars in a manner compliant with this Section. The label applied shall state: WARNING - IF THIS CONNECTOR OR CABLE IS

LOOSE OR MUST BE REMOVED, PLEASE CONTACT THE MDF/IDF MANAGER, OPTICAL PLAN ENGINEER, AND BUILDING ENGINEER

B. Label each ground cable with a unique identifier.

3.5 CABLE LABELING

A. Legibly label all telecommunications cable.

B. Employ a cable labeling and tagging scheme which meets TIA-606 specifications, and as outlined herein.

C. Use “Brady” model TLS-2200 labeling machine or equivalent in cable labeling production.

D. Labeling on the actual cable, apparatus, places, rooms, etc., may have some of the fields listed in the Universal Labeling Schema “hidden” at the discretion of the Owner’s Representative and Designer. The complete label will appear in all databases and lists.

E. Furnish and install construction labels on all cables as they are pulled. These labels shall contain the same information as the finished labels as they will be the only labels applied to cables that are not terminated as part of this project. Place these labels within 8 foot (2.44 meter), and again within 1 foot (0.305 meter) of each end of all cables.

F. Each cable shall have a unique number that shall comply with the requirements set forth herein.

G. Labels shall be numbered according to the project's labeling schema. The scheme shall include to-from information for all tie cables including the building identifier, floor identifier, and room/cabinet identifier. The outlet cable scheme shall include the building identifier, floor identifier, location identifier, and jack / coupler identifier.

H. Patch cables shall be labeled at both ends with a unique, serialized eight-character number that includes cable type. Cable types are MM (multimode fiber), SM (single-mode fiber), U6A (Category 6A UTP), and U6 (Category 6 UTP). Labels used on patch cables shall be heat-shrink-tube type.

3.6 LABELING SCHEMA

A. Follow the Owner's naming convention and labeling schema, as described in Owner's Project Requirements. Contact Owner’s Representative for direction regarding aspects not addressed in Owner's OPR.

B. Submit resulting labeling schema for approval prior to proceeding with manufacturer, fabrication, and application of labels.

END OF SECTION 270553

SECTION 271619 – COMMUNICATIONS PATCH CORDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fiber-Optic Cables (Jumper Cords), Single Mode

B. Unshielded-Twisted Pair Patch Cords

C. Twisted-Pair Cross-Connecting Wire

1.2 RELATED REQUIREMENTS

A. Division 01 - General Requirements.

B. Section 270526 - Grounding and Bonding for Communications Systems.

C. Section 270528 - Pathways for Communications Systems.

D. Section 270553 - Labels for Communications Systems.

1.3 REFERENCE STANDARDS

A. Referenced standards shall be the latest editions adopted as of the Project bid date, unless indicated otherwise in this Section or in codes or laws adopted by the jurisdiction where the Project is located.

B. Telecommunications Industry Association:

1. TIA/EIA 568 - Commercial Building Telecommunications Cabling Standard.
2. TIA/EIA 568.2-D: Copper Cabling Standards Basis.
3. TIA/EIA-569 - Telecommunications Pathways and Spaces.
4. TIA/EIA-455-31-C: FOTP-31 Proof Testing Optical Fibers by Tension.

C. United Laboratories (UL):

1. UL 94 - Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.4 SUBMITTALS

A. See Section 013300 - Submittal Procedures for submittal procedures.

B. Product Data:

1. Furnish product data for each product to be supplied.

1.5 QUALITY ASSURANCE

A. Comply with provisions of TIA/EIA-569 - Telecommunications Pathways and Spaces.

B. Qualifications - Manufacturer:

1. Component manufacturers shall be ISO 9001-compliant and shall offer products that are RoHS compliant.
2. Provide products that are UL or CE classified and labeled (as applicable to the Project location).
3. Firms regularly engaged in manufacturing of the specified products, whose products have been in satisfactory use in similar service for not less than five (5) years.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver components and support systems in packaging designed to avoid breakage, bending and scoring finishes. Do not install damaged equipment.

B. Store pathways components and accessories in original cartons and in clean dry space. Protect from weather and construction traffic.

1.7 SCOPE COORDINATION

A. Contractor shall furnish to Owner at turnover: N/A

1.8 CLUSTER TURNUP CABLING SCOPE (ADD ALTERNATE) N/A

PART 2 - MATERIALS

2.1 FIBER OPTIC JUMPER CORDS

A. General:

1. Fiber optic jumper cords shall be factory-made. Field-constructed fiber optic jumper cords are not acceptable.
2. SC-type and LC-type factory installed single-mode fiber optic connectors shall be epoxy or anaerobic adhesive, simplex type with the following specifications:

a. Attenuation: 0.3 dB at 1300 nm average.
b. Reflection: -45 dB typical (-55 dB APC).
c. Connector durability: 0.2 dB change.
d. Connector matings: 500 cycles.

e. Operating temperature: -40 degrees F (-40 degrees C) to 185 degrees F (85 degrees C).
f. Ferrule construction:

1) Zirconia ceramic, domed end, or;
2) Zirconia ceramic, angled end.

g. Ferrule finish: Factory PC, APC, or UPC as required.
h. Housing construction: Engineering thermoplastic.
i. Boot construction: Polyester.

3. Optical fiber cable shall be two (2) strand zip cord type with each 900 µm buffered strand covered in round break out style 0.063 inch (1.6 mm) jacket with integral Kevlar strain relief material.

B. Single-Mode Fiber Optic Jumper Cords (SC/UPC or LC/UPC):

1. Materials:

a. Single-mode, interior tight buffer cordage available with one (1) or two (2) single-mode strands (zip-cord type), possessing the following specifications:

1) OFNR, or CPR rated as required.
2) Breakout type, 0.063 inch (1.6 mm) construction.
3) Sheath color: Yellow.
4) Labeled with a unique designator on each end using a heat shrink white label with black lettering.

b. Furnish unit cost as part of contract bid for provision and installation of jumper cords.

2.2 UTP PATCH CORDS

A. General:

1. UTP contacts shall be 110-type insulation displacement (IDC) type with the following specifications/features:

a. IDC clip material shall be tin over phosphor bronze.
b. IDC housing material shall be flame retardant plastic, UL 94 V-0.
c. Housings shall be partitioned in such a way that the conductors terminated on the contacts are also partitioned.
d. Housing shall provide a minimum of 100 MW resistance between IDC clips.
e. Provide gas-tight connections with insulation-slicing contacts.
f. Allow connection of 22, 24, and 26 AWG (0.35, 0.25, and 0.14 mm^2) solid copper wires.
g. Support up to 200 insertion/removals without compromising the electrical or mechanical integrity of the IDC connection.

h. Support total outside wire diameters (over insulation) of 0.027 inch (0.7 mm) to 0.045 inch (1.14 mm).

2. Modular jacks shall meet the following requirements:

a. Shall be 8-pin, non-keyed, individual module contact, RJ45 type.
b. Shall be FCC Part 68, Subpart F compliant.
c. Wire material shall be 50 micro-inch (1.27 micrometer) of gold plating over 100 micro-inch (2.54 micrometer) of nickel-plating over phosphor bronze.
d. Shall have a current rating of 1.5A maximum.
e. Insulation shall provide a minimum of 500 MW resistance.
f. 8-pin jacks shall accept 6-pin modular plugs without damage to pins 1 or 8 and shall provide proper electrical continuity for the 6-pin plug.
g. Shall have a contact force of 3.5 oz (99.2 g) minimum using an FCC-approved modular plug.
h. Contact resistance shall be 1 mW maximum.
i. Shall be capable of 750 insertion cycles.
j. Body material shall be hard polyester or polycarbonate with a UL 94 V-O flammability rating.

3. Modular plugs shall meet the following requirements:

a. Shall be 8-pin, non-keyed RJ45 type.
b. Shall be FCC Part 68, Subpart F compliant.
c. Wire material shall be 50 micro-inch (1.27 micrometer) of gold plating over 100 micro-inch (2.54 micrometer) of nickel-plating over phosphor bronze with selective 24-karat hard gold plating in the contact areas.
d. Shall have a current rating of 1.5 A maximum.
e. Contact resistance shall be 10 mW maximum.
f. Shall be capable of 750 insertion cycles.
g. Wire contacts shall be capable of using stranded or solid wire under separate part numbers.
h. Body material shall be polycarbonate with a UL 94 V-O flammability rating.

4. UTP patch cords, plugs and stranded cable, shall meet the specifications of and values appearing within ANSI/TIA 568.2-D for Category-6 cabling.
5. All UTP patch cordage shall have min #24 AWG stranded round copper conductors with snagless strain relief boots.
6. Minimum warranty to meet or exceed the structured cabling installation warranty.

B. Materials:

1. Category-6 4-pair cable tested to 250 MHz possessing the following features/specifications:

a. Factory terminated, Sequence B, with RJ45, 8-position, 8-conductor plug on both
b. Labeled with a unique designator on each end using a heat shrink white label with black lettering.

2. UTP Patch Cord Distribution Cable Coloring:

3. Table 1. UTP Patch Cord Distribution Cable Coloring.

System	Unified Systems Color Codes
Power Monitoring System	Purple
BMS (Non-Critical BAS)	White
CorpNet - Data (User)	Blue
Fire	Red
CCTV = IP Cameras	Yellow
Access Control	Orange
Audio Visual	Black
CorpNet Wireless Access Point	Blue
Patch Panel to network switch at equipment	Colored (to match system) tape/heat shrink both ends of cable with a wire marker identifying the source-destination of the cable.
NOTE:	When patch panels are used for copper cable, the jacks color and patch cables shall match the cable coloring scheme.

C. Furnish unit cost as part of contract bid for provision and installation of patch cords.

D. Manufacturer and product or model:

1. Any certified CAT6 patch cords meeting or exceeding the above specifications.
2. Panduit:

a. For GEN (CORP) network requirements Panduit patch cords shall be used to certify the Panduit system installation.

PART 3 - EXECUTION

3.1 GENERAL

A. Install and place in final position any item, equipment, or material complete and ready for the intended use; fully connected and interfaced, and in operable condition per manufacturer recommendations unless otherwise noted. Perform any manufacturer or Owner required testing and documentation.

3.2 FIELD QUALITY CONTROL

A. Patch cords shall be installed in accordance with Owner requirements and EIA/TIA 568 specifications. Observe EIA/TIA dressing requirements, cable manufacturer's bend radius, and maximum strip back when installing and terminating cables.

1. Contractor shall submit an RFI requesting Owner documentation and requirements for installation and dressing.

B. Protect cords and maintain manufacturer's bend radius.

C. Route and dress patch cords and fiber jumpers to avoid congestion, ensure accessibility, and guarantee proper maintenance clearance between cable/wire terminals.

D. Protect cords from sharp metal edges.

3.3 FIBER OPTIC JUMPER CORDS

A. Furnish single-mode fiber optic jumper cords with length required to connect devices requiring fiber jumper cords.

B. Install single-mode fiber optic jumper cords between the fiber termination blocks (FTBs) within the ODF frame and equipment located within designated racks deployed within the MDF.

C. Route fiber optic jumper cords between endpoints using the overhead fiber guide system (fiber trough).

D. Dress jumpers neatly into points of connectivity at both ends using cable management systems and Velcro cable wraps as required.

E. Jumper cords shall be dressed so that bend radius control is maintained in all locations.

3.4 UTP PATCH CORDS

A. Furnish UTP patch cords with length sufficient to connect from patch panel to final port.

B. Install UTP patch cords between equipment located within designated racks deployed within the MDF.

C. Dress patch cords neatly into points of connectivity at both ends using cable management systems and Velcro cable wraps as required.

D. Patch cords shall be dressed so that bend radius control is maintained in all locations.

3.5 LABELING

A. Legibly label cords at both ends.

B. Legibly tag cross-connect pair groupings.

C. Labels shall be machine printed. Handwritten labels are not acceptable.

D. See Section 270553 - Labels for Communications Systems for labeling requirements.

3.6 TESTING AND COMMISSIONING

A. Perform channel testing as required to confirm compliance with relevant standards and specifications appearing herein subsequent to the installation of cords.

END OF SECTION 271619

SECTION 272133 – DATA COMMUNICATIONS WIRELESS ACCESS POINTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and the Construction Agreement, including any Amendments thereto, and Sections in Division 01, apply to this Section.

1.2 SUMMARY

A. Wireless Access

1. Permanent Wireless Access
2. Construction WiFi shall be provided on best efforts scope, and CFCI.

1.3 RELATED REQUIREMENTS

A. Division 01 - General Requirements: All applicable sections.

B. Section 078400 - Firestopping.

C. Section 270526 - Grounding and Bonding for Communications Systems.

D. Section 270553 - Labels for Communications Systems.

1.4 REFERENCE STANDARDS

A. The referenced standards shall be the latest editions adopted as of the Project bid date, unless indicated otherwise in this Section or in codes or laws adopted by the jurisdiction where the Project is located.

B. National Fire Protection Association (NFPA):

1. ANSI/NFPA 70 - National Electrical Code.

C. National Electrical Manufacturers Association (NEMA):

1. NEMA VE 1 - Metal Cable Tray Systems.
2. NEMA BI-50016 - Cable Tray Installation Guidelines (formerly known as NEMA VE2).

1.5 SUBMITTALS

A. Submit in compliance with requirements of Section 013300 - Submittal Procedures.

B. Product Data:

1. Furnish Product Data for each type and configuration of device or equipment to be supplied, where the installation is temporary.

1.6 QUALITY ASSURANCE

A. Qualifications - Manufacturer:

1. Permanent Wireless Access Points are OFCI.
2. Construction WiFi (where provided) shall be provided on best efforts scope, and CFCI.

B. See Section 270000 – Communication General Requirements for additional requirements.

C. Comply with provisions of TIA-569 - Telecommunications Pathways and Spaces.

D. Qualifications - Manufacturer:

1. Component manufacturers shall be ISO 9001-compliant (current iteration) and shall offer products that are RoHS compliant.
2. Provide products that are UL and/or CE classified and labeled (where applicable).
3. Firms regularly engaged in manufacturing of the specified products, whose products have been in satisfactory use in similar service for not less than five (5) years.

E. Qualifications - Contractor:

1. Refer to Section 270000 – Communication General Requirements.

F. Coordination: Use shop drawings to conduct in-depth coordination with building structure (shell and core) and all other infrastructure (MEP, and other building systems).

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to avoid breakage. Damaged equipment shall not be installed.

B. Store all materials and accessories in original cartons and in a secure, clean dry space; protect from weather and construction traffic.

PART 2 - PRODUCTS

2.1 WIRELESS ACCESS POINTS

A. General:

1. All access points shall be deployed according to Contract Drawings to avoid potential interference from RF sources or other metallic structures, such as light fittings.
2. Access point installation shall use the final patch schedule and configuration schema to avoid signal degradation and/or channel interference.
3. Access points shall be installed horizontally 10-12 feet (3-3.6 m) clear line of sight from the finished floor to the bottom of the AP (as installed).
4. Wall mounted APs shall be included if agreed with Owner as an exception.
5. Permanent wireless access points are OFCI, and shall be IEEE 802.11ac and IEEE 802.3af compliant.
6. Construction wireless access points are CFCI and shall be installed on a standalone network during construction.
7. Installation accessories shall be standard manufacturer's parts, installed according to manufacturer recommendations.

B. Materials and Finishes:

1. AP color shall be white.

C. Manufacturer and product or model (OFCI):

1. Aruba
2. Models:

a. Indoor

1) AP535

b. Outdoor

1) AP534
2) Accessories

c. AP-ANT-48 (Antenna)

D. Accessories (CFCI):

1. 2x Ceiling Grid Rail Adapter for Interlude and Silhouette Mount Kit

a. AP-220-MNT-C2.

2. Industrial Grade Indoor Access Point Metal Suspended Ceiling Rail Mount Kit.
3. AP-MNT-CM1 Flat Surface Wall/Ceiling White AP Basic Flat Surface Mount Kit.

a. AP-220-MNT-W1W.

4. A Series Ceiling Tile Mount Kit

a. P-320-MNT-T AP-320.

5. 2x Ceiling Grid Rail Adapter for Basic Flat Rails Mount Kit

a. AP-220-MNT-C1.

PART 3 - EXECUTION

3.1 GENERAL

A. Confirm pathways are built, furnish all materials and required accessories, miscellaneous components, and parts required to install a complete system.

B. Install the access points using appropriate manufacturer accessories as necessary to comply with local seismic codes, and per Contract Drawings - ensuring not to impede maintenance access to other infrastructure.

C. Bolts, nuts and screws shall be tightened to the manufacturer's torque specifications.

D. Exposed threaded rod shall be covered with plastic conduit.

E. Provide cable connections as indicated on the Contract Drawings, and as directed by Owner’s Representative.

1. WAPs are patched into ENET0 port on the WAP with Category 6A cable, and patched into the network port on the switch. See Contract Drawings for patch schedules.

F. Label the access point and all cables in accordance with Section 270553 - Labels for Communications Systems.

G. Install and place in final position any item, equipment, or material complete and ready for the intended use; fully connected and interfaced, and in operable condition per manufacturer recommendations unless otherwise noted; and perform any manufacturer or Owner required testing and documentation.

3.2 GROUNDING

A. Wireless access points shall be grounded in accordance with manufacturer’s requirements.

3.3 TESTING

A. Confirm power is present at each installed wireless access point.

B. Confirm the access point passes the boot sequence.

3.4 FIRESTOPPING REQUIREMENTS

A. Contractor shall firestop through penetrations and construction gaps created by cutting and patching in compliance with Section 078413 - Penetration Firestopping.

END OF SECTION 272133

SECTION 280800 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the inspection, testing, and commissioning requirements for Electronics Safety and Security Systems. This Section only covers the equipment specific verification and testing requirements. The following Electronics Safety and Security systems are included but limited to:

1. Video Surveillance System (VSS).
2. Access Control system (ACS).
3. Security Portal.
4. Fire Alarm Systems.

1.2 RELATED REQUIREMENTS

A. Section 013300 - Submittal Procedures.

B. Section 014000 - Quality Requirements.

C. Section 017700 - Closeout Procedures.

D. Section 017900 - Demonstration and Training.

E. Section 087100 - Door Hardware.

F. Section 260500 – Common Work Results for Electrical (for reference only).

G. Section 281300 - Security Systems.

H. Section 283111 - Digital, Addressable Fire-Alarm System.

I. Equipment Sections for Electronics Safety and Security Equipment Included in Section 281300 Security Systems.

1.3 SUBMITTALS

A. Test reports, including records of test results. Test values shall be clearly identified and tabulated. Reports shall include but not be limited to the following tests:

1. Factory acceptance/witness test reports.
2. Installation checklists.
3. Startup checklists/reports.
4. Preliminary functional testing reports.

PART 2 - PRODUCTS

2.1 SYSTEM PARTS and INTERFACES

A. The Access Control System includes but is not limited to:

1. Card Reader Controller Units.
2. Card Readers.
3. Door Alarm Contacts.
4. Key Boxes.
5. Local Audible Alarms (LDA).
6. Wire and Cable.
7. Power Supplies.
8. Automatic Transfer Switch (ATS).
9. Enclosed, Securable Rack Cabinets.

B. The Video Surveillance System includes but not limited to:

1. IP cameras, enclosures, and mounting equipment.
2. Wiring, including fiber optic wiring.
3. Camera licenses.
4. Video Network switches (Contractor Furnished Contractor Installed CFCI).
5. Fiber Optic Transceiver Modules for Network Switches.
6. Equipment racks/cabinets.
7. Fiber Optic Transceivers.
8. Fiber Optic Transceiver Power Supply.
9. Power supplies.

C. Products Furnished and Installed by Owner:

1. Network Video Servers including programming.
2. ACS servers including programming and licenses.
3. ACS and video client workstations.

D. Products Furnished and Installed as part of the Security System:

1. Fiber Optic Backbone.
2. CAT 6 cable for cameras, IP access controllers, and intercoms.
3. Local Area Network Ports.
4. Electric locking hardware with.

    a. Request-to-exit switch.
    b. Latch bolt monitoring switch.
    c. Any associated power supplies.

5. Power transfer hinges, as specified in Section 087100 - Door Hardware.
6. Fire Alarm Interface Zone Addressable Module (ZAM).

E. Interface with the Security System:

1. Fire Alarm.
2. Electric Door Hardware.

PART 3 - EXECUTION

3.1 GENERAL

A. Where test plans exist, the requirements in them supersede any conflicting requirements in this specification. All equipment shall be properly packaged, handled, protected, and stored to avoid damage, moisture condensation, water intrusion, and excessive foreign particle encroachment. Refer to gPOR “Specific” Cx Execution plan for further details.

B. Level 1 Factory Testing

1. Performed by the Manufacturer.
2. Integrator Witness Testing (IWT) shall be provided by Manufacturer and/or Integrator for specific equipment in accordance with Section 019113 – General Commissioning Requirements.
3. I2 and I3 testing will be carried out in conjunction with Owner appointed CxA and DCOps.

C. Level 2 Installation Verification

1. Installation verification and pre-start checkout shall be completed for all equipment included below and shall be in accordance with manufacturer’s requirements.
2. Perform procedures for equipment included in each Section below and in accordance with Section 281300 - Security Systems.
3. Performed by the Security Integrator during equipment installation:

    a. Inspect all incoming equipment upon delivery to the site.
    b. Submit L2 checklists and functional testing scripts.
    c. Witness sampling installers, installation means and methods sufficient to be confident proper procedures are being utilized.
    d. Submit completed equipment vendor and/or subcontractor installation quality control documentation.
    e. Submit Daily/weekly Cx meeting minutes.
    f. Submit Weekly/Monthly progress reports.
    g. Submit a system readiness letter for L2 Commissioning confirming that all the security systems as per scope have been installed with L2 Cx completed, along with relevant artifacts.

D. Level 3 Energization, Start-up, and Preliminary Functional Testing

1. Energization, start-up, and preliminary functional testing shall be completed for all equipment included below and shall be in accordance with manufacturer’s requirements.
2. Perform procedures for equipment included in each Section below and in accordance with Section 281300 - Security Systems.

3. Testing performed by the Security Integrator and all associated trades, that is, Door and door hardware, gates, Owner, and others as specified.

    a. Completed Level 3 Blue Tag checklists.
    b. Witness of key startup events/tests per the Cx Plan.
    c. Pre-functional tests (PFT) and "Dry Run" of Level 4 functional testing scripts for Security Systems.
    d. Completed CMMS asset attribute data collection sheets.

4. All security equipment including that performed or installed by other trades, contained in related specification Sections and Level 2 Cx, must be completed by the MDA Ready milestone, after which the Corporate Network communications are established, and the security systems are able to communicate to the servers in the centralized security center.

    a. Level 3 Cx is complete when:

        1) All security systems are fully functional.
        2) Punchlist items have been resolved and retested.
        3) All doors are working as specified (no door hardware issues).
        4) The system is ready for L4 CxA testing.

    b. Energize equipment per approved energization plan and procedures provided by Contractor and Installer.
    c. Contractor is responsible for reviewing, coordinating and confirming that all energization, start-up and preliminary functional testing activities are complete and systems are ready for Level 4 functional testing.
    d. If the results of the field testing show the equipment to be deficient, the Supplier shall make the necessary repairs or alterations to correct the deficiency at no additional cost.

E. Witnessed Level 3 Activities (combined L3/4)

1. Generally, Level 3 testing activities shall be distinct from Level 4 activities. L3 shall be completed (Contractor shall ensure the system is fully functional prior to completing the Blue Tag) prior to executing L4. However, for select activities that are onerous, expensive, impractical, or destructive to repeat, Contractor shall schedule the activity to allow the participation of Owner and Commissioning Agent (CxA).
2. Required witnessed L3 tests are defined below for applicable systems.
3. Contractor shall provide a minimum of two weeks' notice of these activities.
4. Contractor shall perform all supporting QC prior to these witnessed activities, to minimize issues and expedite testing.
5. Contractor shall initially lead execution of the L3 process. CxA shall observe these testing and complete applicable portions of the L4 script based on that observation. CxA will then direct any additional testing that needs to be done with respect to that combined activity to complete the relevant portion of the L4 script.
6. All issues identified during these witnessed L3 activities shall be recorded and tracked in the QCx Tool.
7. During Level 3 testing, Installer/manufacturer will provide the necessary support to complete the testing with Contractor, CxA and DCIO.

F. Level 4/5 Testing Support

1. Installer and Manufacturer shall each provide on-site support as required by each of the equipment sections in this specification and in accordance with Section 019113 – General Commissioning Requirements. This time will be spent exclusively in support of the Commissioning Agent and DC Operations Staff for executing the Level 4 and 5 testing procedures.
2. Contractor must provide and accept daily work tickets. Tickets must detail hours spent on Level 4/5 support. As part of the bid submittal, state the hourly rate for field support in excess of this time requirement.
3. Installer and Manufacturer shall identify the required skills and number of individuals required for support along with hourly rates for regular, overtime, and premium time.
4. Support staff shall be dedicated to this project and may be assigned work continuously until successful Level 4 and 5 commissioning completion.

3.2 QCx REQUIREMENTS FOR COMMON ELEMENTS

A. The following QCx requirements apply to the common elements that make up the systems addressed below. Apply these requirements when the listed components/elements are part of those systems.

B. All Components and Elements

1. Level 2 Installation Verification

a. Inspect equipment once it arrives at the site and confirm it is in acceptable condition.
b. Confirm installation is in conformance with the contract documents and manufacturer's recommendations. Review all applicable design details and confirm installation conforms with specifications.
c. Confirm that installed systems, components, and devices are in accordance with approved submittals.
d. Inspect equipment prior to startup and confirm that it is free from visible damage and defects.
e. Verify that access is provided for inspection, operation, and repair/replacement.
f. Verify that all labeling is affixed to the system and in conformance with the specifications.
g. Verify that specified replacement material and spare stock has been provided as required by Contract Documents.

C. Level 3 Energization, Start-up, and Preliminary Functional Testing

1. Confirm the system has been started up per the manufacturer's recommendations.
2. Confirm that all elements of the system have been cleaned and are ready to turnover for Level 4 testing.
3. Confirm that all labeling is affixed to the component and is in conformance with Contract Documents.
4. Confirm that record drawings of the equipment installation are available.
5. Confirm that all construction deficiencies and issues have been resolved.

6. Confirm that all monitoring and ensure all alarms are active and set per Owner's requirements.
7. Complete the applicable Section of the Load Sheets, Test Plans and submit as a part of Blue Tag.

D. Level 4/5 Testing Support

1. Installer and Manufacturer shall each provide on-site support as required by each of the equipment Sections in this specification and in accordance with Section 019113 – General Commissioning Requirements. This time will be spent exclusively in support of the Commissioning Agent and DC Operations Staff for executing the Level 4 and 5 testing procedures.
2. Daily work tickets must be provided and accepted by Contractor. Ticket must detail hours spent on Level 4/5 support. As part of the bid submission, state the hourly rate for field support in excess of this time requirement.
3. Installer and Manufacturer shall identify the required skills and number of individuals required for support along with hourly rates for regular, overtime, and premium time.
4. Support staff shall be dedicated to this project and may be assigned work continuously until successful Level 4 and 5 commissioning completion.

3.3 VIDEO SURVEILLANCE SYSTEM

A. Level 1 Factory Testing

1. Performed by the Manufacturer.
2. Integrator Witness Testing (IWT) shall be provided by Manufacturer and/or Integrator for specific equipment in accordance with Section 019113 – General Commissioning Requirements.
3. I2 and I3 testing will be carried out in conjunction with Owner appointed CxA and DCOps.

B. Level 2 Installation Verification

1. The following field installation verification and pre-start checks shall be completed by the Installer, including documentation as specified in Section 281300 - Security Systems:

    a. Refer to current edition of UL 2610 - Standard for Commercial Premises Security Alarm Units and Systems, NEC (NFPA 70), and IEEE 802.3 (at or after), Standard of Installing Closed Circuit Television (CCTV) Systems for required installation practices.

2. Contractor shall furnish the services of a competent person to ensure equipment has been installed in accordance with manufacturer's requirements prior to start-up, including documentation as specified in Section 281300 - Security Systems.
3. For camera installation, verify the Field of View and capture a screenshot for each installation.
4. Submit all camera screenshots with the Field of View verified as per design, as an artifact for completion of L2 Commissioning.

C. Level 3 Energization, Start-up, and Preliminary Functional Testing

1. Contractor shall furnish the services of a competent person to perform start-up, checkout, and testing of equipment according to manufacturer's requirements. Contractor shall support testing as required.
2. Provide support for building wide cause and effect testing.
3. The following shall be completed at a minimum including documentation as specified in Section 281300 - Security Systems:

    a. Complete testing per UL, NEC, and NFPA requirements.
    b. Perform preliminary functional testing not listed above to ensure all controlled and monitored equipment is operating per approved sequence of operation and Level 4 testing scripts (provided by CxA).

        1) Confirm that Corpnet is operational and the iSTARs are communicating.
        2) Confirm that the IRIS scanners are operational and communicating to the server.
        3) Confirm that alarms and events are annunciated at the control console and at the offsite monitoring station (Mountain View).
        4) Verify that all supervisory alarms are clear.
        5) Confirm that the iSTARs and DCMs are UPS powered and powered by dual sources.
        6) Confirm that all egress doors that do not have a mechanical override and have an interface to the fire alarm system.
        7) Confirm that the fire alarm system Transmits a Fire Alarm signal, Tamper Signal, and Trouble signal to the ACS.

D. Level 4/5 Testing Support

1. Installer shall provide at a minimum 1 hour per zone (as defined in Contract Drawings) of on-site support for the duration of Level 4 and 5 testing in accordance with Division 1 requirements. This time will be spent exclusively in support of the Commissioning Agent and DC Operations Staff for executing the Level 4 and 5 testing procedures. Daily work tickets must be provided and accepted by Contractor. Tickets must detail hours spent on Level 4/5 support. As part of the bid submission, state the hourly rate for field support in excess of this time requirement.

3.4 ACCESS CONTROL SYSTEM

A. Level 1 Factory Testing

1. Performed by the Manufacturer.
2. Integrator Witness Testing (IWT) shall be provided by Manufacturer and/or Integrator for specific equipment in accordance with Section 019113 – General Commissioning Requirements.
3. I2 and I3 testing will be carried out in conjunction with Owner appointed CxA and DCOps.

B. Level 2 Installation Verification

1. The following field installation verification and pre-start checks shall be completed by Installer including documentation as specified in Section 281300 - Security Systems.

    a. Refer to current edition of UL 2610 - Standard for Commercial Premises Security Alarm Units and Systems, NEC (NFPA 70), and IEEE 802.3 (at or after) for required installation practices.

2. Contractor shall furnish the services of a competent person to ensure equipment has been installed in accordance with manufacturer's requirements prior to start-up, including documentation as specified in Section 281300 - Security Systems.
3. Installer shall set up an offline/standalone version of the access control application, same as the one used by Owner, on a local computer/PC (provided by Installing Contractor). Thereafter, program & test all the devices' functionality, replicating the live environment. A complete system-generated test & alarm report along with system health status to be submitted as an artifact to declare L2 Commissioning completion.
4. Installing Contractor shall furnish the services of a competent person to ensure equipment has been installed and tested in accordance with manufacturer's requirements. Refer to Section 087100 - Door Hardware. Verify that:

    a. Equipment installed is consistent with specified Door Type and Specification.
    b. Equipment installed is consistent with approved shop drawings.
    c. The door hardware is installed, adjusted and operational.
    d. Verify cables are protected and neatly secured.

5. Card Readers and Local Door Alarm ADA

    a. Verify ACS Door location matches the location on the drawing.
    b. Verify that the card reader is labeled as per specifications.
    c. Verify that the DCM is mounted per the contract drawings and specifications.
    d. Verify that there is an 8" horizontal separation from other card readers when the readers are installed directly opposite from each other on the same wall.
    e. Verify that the card reader is securely mounted and level.
    f. Verify card reader mounting height is as per specification.
    g. Verify that the DCM is grounded.
    h. Verify that the cabling is concealed in public areas and secured above ceilings.
    i. Verify equipment installed agrees with shop drawings and specified door type.
    j. Verify that local door alarms are located on the high secure side of the door at the measurement in the specification.
    k. Cable raceways are complete, securely anchored & inspection box lids are fitted.

C. Level 3 Energization, Start-up, and Preliminary Functional Testing

1. Contractor shall furnish the services of a competent person to perform start-up, checkout, and testing of equipment according to manufacturer's requirements. GC/CM shall support testing as required and provide support for building wide cause and effect testing. The following shall be completed at a minimum including proper documentation:

    a. Cabinets

1) Confirm that dual power sources are available for all access control equipment and the ATS is operational.
2) Confirm that the RM voltages are within tolerance.
3) Confirm that all cables are concealed in public areas and secured above ceilings.
4) Confirm all wiring terminations are correct.
5) Confirm that the system is free of open and shorted loops.
6) Confirm incoming voltage readings.

b. Confirm all level alarming.

1) Tamper Switches are installed correctly.
2) Tamper/ Supervisory/ Alarms at the Local Control Panel.

c. Card Readers and Local Door Alarm LDA

1) Confirm that the card readers function per the contract documents.
2) Confirm that LDA operation and function per the contract documents.

D. Level 4/5 Testing Support

1. Installer shall provide at a minimum 1 hour per zone (as defined in Contract Drawings) of on-site support for the duration of Level 4 and 5 testing in accordance with Division 01 requirements. This time will be spent exclusively in support of the Commissioning Agent and DC Operations Staff for executing the Level 4 and 5 testing procedures. Daily work tickets must be provided and accepted by Contractor. Tickets must detail hours spent on Level 4/5 support. As part of the bid submission, state the hourly rate for field support in excess of this time requirement.

3.5 SECURITY PORTAL (CIRCLELOCK AND TOURLOCK)

A. Level 1 Factory Testing

1. Performed by the Manufacturer.
2. No requirements for security scope.

B. Level 2 Installation Verification

1. The following field installation verification and pre-start checks shall be completed by Installer including documentation as specified:

a. Circlelock Physical

1) Verify that the ceiling panels are in place and secure.
2) Verify that the Circlelock door locations match the contract documents.
3) Verify that the Circlelock is clean, the track is free of debris and the stereo vision sensors are dust free.
4) Verify that the floor is level where the Circlelock is installed with a max tolerance of 3/16".

5) Verify that the mag lock assembly is aligned with the door and the mag lock is secure.
6) Verify that the sliding door end stops are adjusted and secure.
7) Verify that device cabling is secure, bundled neatly and clear of all moving parts.
8) Verify that the unsecure sliding door slides without binding.
9) Verify that the swing door secures and locks without binding.
10) Verify that the doors are locked and secure when closed.
11) Confirm that the installation is free of damage, corrosion, or defect.
12) Confirm that the cables are protected at entry points by brushes, grommets, or glands. Brushes & glands checked for tightness.
13) Verify that all cabling is neatly dressed & secured.
14) Verify that all cabling is correctly labeled.
15) Verify that a cable tug test has been completed to ensure no terminations are loose.
16) Verify that all Readers & similar interfaces are securely mounted & level.
17) Verify that all readers have been labeled and marked on the as fitted drawings.
18) Verify that the power feed is labeled.

b. Refer to current edition of UL 2610 - Standard for Commercial Premises Security Alarm Units and Systems, NEC (NFPA 70), and IEEE 802.3 (at or after) for required installation practices.

2. Installer shall furnish the services of a competent person to ensure equipment has been installed and checked out in accordance with manufacturer's requirements prior to start-up.

C. Level 3 Energization, Start-up, and Preliminary Functional Testing

1. Installer shall provide a factory authorized service representative to perform start-up, checkout, and testing of equipment according to Contract requirements. Contractor and Installer shall coordinate with Owner and CxA during the initial fill to allow witnessing of the calibration of the level transmitters and switches. The following shall be completed at a minimum including proper documentation:

a. Circlelock Operation

1) Confirm that pre-Functional checkout defects have been addressed.
2) Confirm that RM voltages are within 10% of required voltages.
3) Confirm that the ICAM devices are online and operational.
4) Confirm that the DCM cabinets are equipped with tamper switches.
5) Confirm that Corpnet is operational and the iSTARs are communicating.
6) Confirm that all alarms are annunciated at control. (including Tamper, Supervisory, Door held, Door forced, LDA alarm, LDA By-pass alarms, and other alarms used in this installation).
7) Confirm that both doors in a double door configuration generate an alarm.
8) Confirm that the doors are adjusted in accordance with manufacturer's requirements and excessive door movement does not generate an alarm.
9) Confirm that the doors close and latch when closed with the door closer.

D. Level 4/5 Testing Support

1. Support for L4 on Circlelock Testing and Operation. Confirm operation and testing of Circlelock integration with the Fire Alarm System, Refer to Integrated System Test (IST) documentation and specifications as per Section 283111 - Digital, Addressable Fire Alarm System.
2. Installer shall provide at a minimum 1 hour per zone (as defined in Contract Drawings) of on-site support for the duration of Level 4 and 5 testing in accordance with Division 01 requirements. This time will be spent exclusively in support of the Commissioning Agent and DC Operations Staff for executing the Level 4 and 5 testing procedures. Daily work tickets must be provided and accepted by Contractor. Tickets must detail hours spent on Level 4/5 support. As part of the bid submission, state the hourly rate for field support in excess of this time requirement.

3.6 FIRE ALARM SYSTEMS

A. Level 1 Factory Testing

1. Not Required

B. Level 2 Installation Verification

1. The following field installation verification and pre-start checks shall be completed by the Installing Contractor including documentation as specified:

a. Installation is in conformance with the drawings and specifications. All applicable details have been checked and found in conformance.
b. Installed systems, components and devices are in accordance with approved submittals.
c. Verify all labeling affixed to the system and all labeling is in conformance with the specifications.
d. All elements in the system have been inspected for damage and have been verified free from consequential damage.
e. Confirm system and all elements that make it up have been checked for adequate maintenance, repair and replacement access and access has been found acceptable.
f. Confirm FACP installed per drawings and code requirements.
g. Verify FACP terminations tight and installed per manufacturer's instructions.
h. Verify all devices (strobes/speakers, smoke/heat detectors, pull stations) are installed per drawing and code requirements.
i. Verify terminations on all devices (strobes/speakers, smoke/heat detectors, pull stations) are tight and per manufacturer’s instructions.
j. Verify size of battery is adequate to power system for code-mandated time period.
k. Verify battery connections are tight and no evidence of leaking or corrosion.
l. Loop Resistance: With indicating circuit installation conductor pair short-circuited at the far end, measured, and recorded the resistance of the circuit.
m. Resistance to Ground: Measured resistance to ground on all frames, system neutral, and derived neutral points.

2. Installer shall furnish the services of a competent engineer to ensure equipment has been installed and checked out in accordance with manufacturer's requirements prior to start-up including documentation as.

C. Level 3 Energization, Start-Up, and Preliminary Functional Testing

1. Contractor shall furnish the services of a competent engineer to perform start-up, checkout, and testing of equipment according to manufacturer's requirements. Contractor shall support testing as required. The following shall be completed at a minimum including proper documentation:

a. Test operation of system when fire alarm device is activated.
b. Test when fire alarm system audible or visual wiring is broken, a trouble condition is annunciated at the FACP.
c. Confirm no Notification Appliance Circuit (NAC) is loaded to more than 75% rating.
d. Validate elevator recall and override functions are correctly implemented.
e. Test that the FACP battery backup will operate the system in this building for a continuous period of 60 hours in standby mode and will then operate the system in a continuous alarm mode for five (5) minutes.
f. Verify each tamper switch actuates the appropriate alarm and indication.
g. Verify each flow switch actuates the appropriate alarm and indication.
h. Validate each device location and alarm is received by lifting the lead at the FACP.
i. Verify that pre-action is indicated correctly to the FACP.
j. Verify each zone is indicated correctly to the FACP.
k. Confirm that each remote indicating station properly functions.
l. Verify each zone detection sensitivity is correctly set.
m. Strobe Test: Activate system alarm. Verify adequate visibility throughout protected areas.
n. Speaker Test: Activate system alarm. Verify adequate sound pressure level with sound level meter meeting ANSI S-1.4a. Measure and record levels throughout protected areas.
o. Paging Test: While the system is in alarm and AV devices are active, make announcements through the fire alarm paging system. Verify the announcements can clearly be heard in all spaces throughout the building.
p. Verify Trouble Alarm for Devices: Remove one wire from 10% of devices per zone/circuit (minimum of 2). Verify that trouble was correctly enunciated at the FACP and remote annunciator panel.
q. All system equipment shall be 100% tested by Contractor and all system malfunctions corrected before Owner is advised that any formal acceptance testing is ready to begin. A preliminary hardcopy test report shall be given to Owner after the informal acceptance testing is complete indicating when each smoke detector was cleaned (if applicable) and tested, and the results of the preliminary testing and any problems encountered and/or repaired.
r. Prior to formal inspection and testing, clean and test each smoke detector that has not been covered at the supplier's factory and remained covered during the entire construction period. All smoke detectors shall be cleaned according to the manufacturer's written recommendations. Notify Owner before smoke detector cleaning is started so that periodic inspection of the cleaning process may be performed.

s. Formal field tests shall be performed under the supervision of a factory-trained field technician in the presence of Owner's Representative. Tests shall be performed on each circuit and device of each system (100% test). On any circuit where malfunctions occur, the defective device within the malfunctioning circuit shall be repaired and retested. A comprehensive hard copy field test report shall be given to Owner upon completion of the formal test.

t. All informal and formal field test hard copy report formats shall be structured to show an individual reference to each point and/or zone within each system. The format shall be structured to indicate the test date for each device tested and the results of each test. Contractor Representative who witnessed the associated test shall sign each test report page.

u. Provide personnel and equipment required to perform informal and formal field testing. Owner's Representative will act in an observation role only with reference to testing.

v. Final Acceptance of system will not be considered by Owner until all punchlist items have been corrected. Beneficial use of the system will not be considered as Full or Partial Acceptance.

2. Perform preliminary functional testing not listed above to ensure all controlled and monitored equipment is operating per approved sequence of operation and Level 4 testing scripts (provided by CxA).

D. Level 4/5 Testing Support

1. The Installing Contractor shall provide, at a minimum, 120 Hours of on-site support for the duration of Level 4 and 5 testing in accordance with Division 01 requirements. This time will be spent exclusively in support of the Commissioning Agent and DC Operations Staff for executing the Level 4 and 5 testing procedures. Daily work tickets must be provided and accepted by Contractor. Tickets must detail hours spent on Level 4/5 support. As part of bid submittal, state the hourly rate for field support in excess of this time requirement.

END OF SECTION 280800

SECTION 281300 - SECURITY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY (NON-INCLUSIVE)

A. Section Includes: Components and subsystems indicated for a complete and operable security system as follows:

1. Security systems include, but are not limited to the following subsystems:

a. Access control system (ACS).
b. Video surveillance system (VSS).
c. Security systems network (SECN).

2. Interface to:

a. Electric door hardware.
b. Fire Alarm System.

B. Access Control System (ACS) includes, but is not limited to:

1. Equipment in the Main Distribution Frame (MDF):

a. Door access controllers
b. Power supplies.
c. Automatic Transfer Switch (ATS).

2. Card readers.
3. Door alarm contacts.
4. Key boxes.
5. Audible visual alarms (AVA).
6. Wire and cable.
7. Power supplies.

C. Video Surveillance System (VSS) includes, but is not limited to:

1. IP cameras, enclosures, and mounting equipment.
2. Wiring, including fiber optic wiring.
3. Camera licenses.
4. Equipment in the MDF (Contractor Furnished Contractor Installed CFCI):

a. Security network ethernet switches

1) Field switches
2) Core switches
3) VMS Server switch (Owner Furnished Owner Installed OFOI)

b. Power supplies

D. Shared Services Rack

1. Shared Service Rack (SSR) of Main Distribution Frame (MDF).

E. Cables

1. Fiber optic backbone from DC to HUB OFOI.
2. CAT 6 cable for cameras (Yellow).
3. Belden Cable for Access Control (Orange).

F. Network

1. IP access controllers.
2. Local area network ports.

G. Doors

1. Electric locking hardware with:

a. Request-to-exit switch
b. Latch bolt monitoring switch
c. Associated power supplies

2. Power transfer hinges (See Section 087100)
3. Fire alarm interface, zone addressable module (ZAM)

1.2 RELATED REQUIREMENTS

A. Consult other Divisions, determine the extent and nature of related work and properly coordinate work specified here with that specified elsewhere to produce a complete and operable system.

B. Division 01: Applicable Sections

C. Section 087100 Door Hardware

D. Division 26: Electrical (for reference only)

E. Section 260519 Low-Voltage Electrical Power Conductors and Cables

F. Section 265100 Lighting

G. Section 280800 Commissioning of Electronic Safety and Security Systems

H. GNarr - Chapter 14: Security - gPOR ALL (UID:8670)

1.3 SCOPE OF WORK

A. General

1. The HUB Security Systems consist of an access control system, building intrusion detection system, video monitoring system,
2. This document with the associated set of Project Security Drawings and related specifications comprises the scope of work to be accomplished.
3. Refer to the Project Security Drawings for actual locations and devices.
4. Coordinate work being done under separate specifications, required for the successful operation of the security systems.
5. Ensure that Access Control System (ACS) requirements are met:

    a. Based on an enterprise access control system maintained and updated by Owner.
    b. Card readers shall be to Owner's corporate standard.
    c. Uptime requirement for the Access Control System shall be 99.999 percent.
    d. Locate ACS controllers in MDF, in security designated racks (provided and installed by others),
    e. The ACS controllers located in the MDF can connect to any card reader in the HUB (Layers 3 through 4).
    f. Provide flush magnetic door alarm contacts on facility personnel doors, whether connected to a card-reader-controlled personnel door or to a non-card-reader personnel door, for door status monitoring. The use of surface-mounted switches are not acceptable on personnel doors.
    g. Ensure that ACS interfaces with the following systems:
    h. Alarm reporting devices
    i. Fire Alarm and VESDA
    j. Provide inputs for general fire alarm outputs to enable secondary monitoring by the ACS.

6. Ensure that Video Surveillance System (VSS) requirements are met:

    a. Video Management Systems (VMS) servers used are provided, programmed, and installed by Owner in the MDF.
    b. Required security network switches are provided and installed to create an independent network using 48 port POE+ capable switches, connected to the cameras, and to a 24 port SFP central network switch (core switch) with redundant links.
    c. Core switch connects to Owner-provided VMS servers and storage units, using redundant fiber links through an aggregation switch. Servers shall also be connected to the corporate network.
    d. Areas monitored by VSS include, but are not limited, to the following: (Project Security Drawings will show the actual locations):

        1) Entrances, main, secondary
        2) Access doors of high security areas
        3) Parking and roadways

    e. Provide camera, directory, and fail-over directory licenses for the VSS; Owner provides and installs all other licenses.

f. Provide camera poles with minimum height of twenty-two feet (6.7m) above ground level, manufactured of spun concrete. Owner shall approve exceptions in writing.
g. Provide hardened security POE network switches at poles with associated power supplies and SFP modules.

7. Ensure that Automatic transfer switch (ATS) requirements are met:

   a. Provide an automatic transfer switch (ATS) in the MDF racks that contain security equipment, required to transfer power between two separate power sources.

8. Ensure that Layer 3 - Building Shell and internal support functions requirements are met:

   a. Access into the building is through the vestibule with a card-controlled door.

      1) Provided according to this section.

         a) Card reader.
         b) Access control door controller and wiring.

   b. Provide the following:

      1) Access control on single and double doors with free exit:

         a) Card reader
         b) Audio visual alarm (AVA)
         c) Flush mounted door position switches
         d) Locking hardware with request-to-exit (REX) switch (provided by others)
         e) See door schedules for locking hardware types.
         f) Cameras monitoring both sides of door capable of facial identification three paces from door.

      2) Alarmed exits, single or double doors

         a) Flush mounted door position switches
         b) Audio visual alarm (AVA)
         c) Panic hardware (delayed where noted on Security Drawings) by others
         d) Cameras monitoring approach to door when exiting door capable of facial identification three paces from door.

      3) Additional camera as shown on the Security Drawings
      4) 48 port ethernet network switches with POE+ capability for video cameras, located in MDF.

9. Ensure that Layer 4 Main Distribution Frame (MDF), requirements are met:

   a. Provide the following:
   b. Card reader-controlled doors
   c. Card reader with keypad - in
   d. Card reader - out

e. Door controllers
f. Flush mounted high security door position switch
g. Audio visual alarm (AVA)
h. Alarmed emergency exits.
i. Flush mounted high security door position switch
j. Audio visual alarm (AVA)
k. Cameras on each side of the door viewing the approach to the door.
l. Comprehensive video surveillance coverage
m. Items located in the MDF Security Racks:
n. Video servers provided and programmed by Owner.
o. iStars supporting the high security area doors.
p. 48 port ethernet network switches with POE+ capability for cameras
q. 24 port video core switches
r. ATSs (to support security equipment)
s. Associated patch panels

10. Ensure that key box system requirements are met:

a. Electronic operation.
b. Provide a smart card reader for the key box.
c. Stand-alone in one or more locations.

1) Be capable of connecting to Owner's network at a future date.

d. Programming of the card reader coordinated with the key box system.
e. Key box system communicates with Owner’s enterprise key management system.

1.4 SUBMITTALS

A. Submit according to the requirements in Section 013300 - Submittal Procedures. Provide submittals (including Shop Drawings) to Owner for review and acceptance.

1. Submittals will be uploaded to BIM360 and shared with Robert Kyle: rkyle@google.com

B. Provide Drawings and Product Data required for the security system in one package. Drawings submitted without Product Data or Data submitted without Drawings will be rejected without review.

1. Failure to provide complete documentation as noted above will be cause for immediate rejection without comment.

C. Shop Drawings: To Design Professional for approval.

1. Before construction related to this Project is started, the security system provider meets with the Electrical Installation Contractor for the system extensions to develop Shop Drawings for the Project.

a. Shop Drawings submitted to the Design Professional for approval include point-to-point wiring diagrams for each new component of the security system extensions specified in this Section.
b. Point-to-point wiring diagrams detail each device location and wire runs between the device, other equipment and proposed wire runs to existing central systems equipment.
c. Shop Drawings detail connections between new and existing equipment and devices. Point- to-point Drawings consist of one of the two following methods:

1) Method No. 1: Provide computer generated floor plan Drawings for each area where work associated with this Project is occurring. The floor plan Drawings detail each system device at its proposed location. Assign each device indicated on the floor plan Drawings an identification number. This method includes an accompanying riser diagram showing new devices and proposed wiring between devices. Key devices on the Riser Drawing to the device locations and device identification numbers indicated on the floor plan Drawings.
2) Method No. 2: Provide computer generated floor plan Drawings for each area where work associated with this Project is occurring. Show on the floor plan Drawings each device location and on the same Drawing, wiring that has been added to outline the proposed wiring that is planned for this Project.

d. Actual conduit and wire routing is not required to be detailed on point-to-point Drawings.

2. Security riser diagrams detail the number of access control units (ACUs), power supplies and other equipment at each associated ACU location.

a. Riser Drawings include cabling, wiring and components proposed to be provided for security related equipment and detail the connections between new security related devices and the central access control and security monitoring system equipment.

3. Video surveillance system riser diagrams detail exact video surveillance system equipment and wiring at each video surveillance system component location.

a. All video surveillance system related riser Drawings submitted include cabling (including fiber optic cabling), wiring and components proposed to be provided for central security and video surveillance system equipment including equipment wiring that will be provided in the Security Control Room.

4. Coordination Details: Show details required to demonstrate that related equipment and other related systems have been duly coordinated; Finish Hardware: Division 08; Section 283111 - Digital, Addressable Fire-Alarm System; Gate and Fencing; and properly function as a complete Security System.
5. Shop Drawings include a complete bill of materials for the Project. The bill of materials submitted identifies the quantity of devices provided for each device type planned for this Project.
6. Provide to Owner information on the video surveillance system cameras to include quantity, types (including megapixels and frame rate), interlaced or progressive scan, color model/depth, compression ratio, and camera locations.

7. Coordinate door hardware and egress plans with Division 8 work.

D. Product Data: To Design Professional for approval. Include a table of content for each system, data sheets on all systems and components, block diagrams of their interrelationships, power and standby battery requirement calculations, and specific operational theories as they relate to Project Specifications.

1. Provide manufacturer’s product data sheets clearly marked to indicate the exact product/device and model of the equipment being provided for this Project.

E. Program Loading Sheets: Provide completed system loading sheets for the access control and video surveillance systems in electronic format.

1. Use Owner-provided electronic spreadsheet template. ONLY owner-issued electronic loadsheet will be used for programming efforts from DC-Sec-Systems.
2. Complete loading sheet cells, including project details. Follow instructions on "Instruction Tab".
3. Identify stakeholders and provide contact information. Will be provided at the Kick-Off Security meeting.
4. Before formal submission, coordinate with the local Site Security Manager for device naming convention. See OneGDC Naming Glossary (UID: 21823).
5. Loading sheets include at a minimum:

a. Access control panels
b. Doors
c. Readers
d. Inputs
e. Outputs
f. I/8, R/8 boards
g. Cameras
h. Core switch ports
i. Video network switch
j. Iris iCAM devices
k. TRAKA Keyboxes

F. Quality Control Procedures: Field Test Reports: See Access Control Systems - Test Plan (UID: 26842).

G. Commissioning Submittals

H. All Cx submittals and sign offs to be completed in Autodesk Build Field Management.

I. Closeout Submittals

1. Refer to:

a. Section 017700 - Closeout Procedures
b. Section 017823 - Operation and Maintenance Data

1.5 QUALITY ASSURANCE

A. Reference Codes and Standards: Use the most current codes and standards at time of construction; comply with the following, but not limited to, in accordance with Division 01. Revise the construction documents as required to list codes and standards applicable to area/country where projects are located.

1. FM Global

    a. Listing Requirements

2. National Fire Protection Association (NFPA)

    a. NFPA 70 - National Electrical Code
    b. NFPA 101 - Life Safety Code

3. Underwriters Laboratories, Inc. (UL)

    a. Labeling and Listing Requirements for Security Use.

4. International Building Code (IBC)
5. National Electrical Contractors Association (NECA)

    a. NECA 303 - Standard for Installing and Maintaining Closed-Circuit Television (CCTV) Systems.

B. Materials

1. Provide new materials and equipment without defects.
2. Provide only specified products and equipment, or products and equipment that have been approved by the Owner in writing.

C. Installer Qualifications

1. A single Contractor, with a technical staff trained and certified in the Software House C•CURE 9000 Enterprise access control system, will provide the security system specified within this Section and proper coordination, uniform quality, and system integrity,
2. Involved with the sale, installation, and servicing of similar systems of size, scope, and complexity of this Project for the past five (5) years.
3. Evidence of technicians qualified for the work in the form of current manufacturer's training certification.

1.6 PROJECT MANAGEMENT AND COORDINATION SERVICES

A. Provide a Project Manager for the duration of the project to coordinate this work with other trades.

B. Coordination services, procedures, and documentation responsibility include, but are not limited to:

1. Obtain copies of Shop Drawings for equipment provided by others that require security connections or inter-service connections or interface with Work.
2. Perform a thorough review of the Shop Drawings to confirm compliance with the service requirements.
3. Document discrepancies or deviations as follows:

    a. Prepare a memo summarizing the discrepancy.
    b. Submit a copy of the specific Shop Drawing, addressing the discrepancy or deviation.

C. Set up and conduct coordination with the following trades through the Contractor:

1. Electrical
2. Door hardware
3. Telecommunications
4. Fire alarm

D. Schedule

1. Typically, there are 24 weeks from the initial kick-off meeting to complete the installation of components before Level 3 Cx testing begins.
2. Sample Abbreviated Schedule. A more detailed schedule will be provided after award of contract.

Security Kick-off Meeting	FDOB Date minus (-) 36 weeks
Shop Drawings Due	FDOB - 30 weeks
Programming Sheet and Camera IP Range	FDOB - 28 weeks
Camera Count	FDOB - 16 weeks
Load Sheets Due	FDOB - 13 weeks
Project Launch Meeting	FDOB - 12 weeks
All Devices Installed & Wired	FDOB - 9 weeks
MDA Ready (Network gets connected)	FDOB - 9 weeks
L3 Cx and Burn-in Period Start. See Section 280800.	FDOB - 6 weeks
L4 Cx Start (3rd Party Verification). See Section 280800.	FDOB - 4 weeks
Cx Punch List Complete and System Acceptance. See Section 280800.	FDOB - 1 weeks
First Day of Business (FDOB)	FDOB - 0 weeks

E. Meetings

1. Typically, 20 meetings require Project Manager attendance.
2. Additional coordination meetings may also be needed.
3. Installation team coordination meetings recommended, and periodic safety meetings.

1.7 WARRANTY

A. Refer to Section 017836 - Warranties.

B. In addition, provide:

1. A Preventative Maintenance Contract covering system equipment four (4) hour guaranteed emergency response service and Scheduled Preventive Maintenance at time of system acceptance. Provide four (4) hour response time during normal working hours only. During non-normal working hours, a 12-hour response is acceptable. Provide this contract at no additional cost for the first year.
2. At time of bidding, include cost of a full-coverage Preventative Maintenance Contract similar to the Preventative Maintenance Contract for second year.

    a. Service/Preventative Maintenance contracts are to be negotiated directly with Owner and will be separate from this scope of work.

3. During warranty period, all maintenance to be consistent with manufacturer's recommendations. After the warranty period, provide service for security devices through scheduled maintenance contracts (by DCIO).

PART 2 - PRODUCTS

2.1 ACCESS CONTROL SYSTEM

A. Approved Product:

1. iSTAR-GCM-2U-X - iSTAR Ultra GCM in 2U Rack Mount Enclosure GCM, 12VDC input. Supports up to 32 readers with addition of ACMs, requires power supply as manufactured by Software House.
2. iSTAR-ACM - iSTAR Ultra ACM Board Supports up to 8 readers as manufactured by Software House
3. RGS250-4D8Z1 - 250W integrated 2U rackmount power system, input voltage 120/230 VAC 50/60Hz. Provides space for ISTAR-ACM board as manufactured by Lifesafety Power

B. Card Readers:

1. Approved Product:

    a. Signo 40 (40NKS-03-0086UQ w/Elite Keys ICE0052) as manufactured by HID.
    b. Signo 40K 40KNKS-03-0086UQ SCR-SE-921N-GGLE w/ Elite Keys (ICE0052) card reader with keypad as manufactured by HID.

C. Biometric Readers

1. Approved Product:

a. iCAM 7000S-B iris recognition reader as manufactured by Iris ID
b. iCAM-PWR Power Supply as manufactured by Iris ID

D. Door Position Contacts

1. Approved Product:

a. MSS-301C-WG-GO, Door Switch Flush Mount as manufactured by Magnasphere.
b. MSS-310S-GO, Door Switch Surface Mount as manufactured by Magnasphere.

2. Personnel Doors:

a. Mounting: Recessed, concealed
b. Installs in one inch (25.4 mm) diameter hole.
c. Contacts: Spherical Magnet Contact
d. Normally closed.
e. Gap Distance: 0.125-inch (3.175 mm) maximum
f. Meets UL-634 Standard Level 1

E. Miscellaneous Access Control Parts

1. 3040CT-W, Panic Switch, SPDT-Latching LED Cold Temperature as manufactured by Interlogix/UTC.
2. TSC-20, SSFR rack enclosure door alarm/tamper switch as manufactured by GRI.
3. 6644-1, Supervisory resistor pack, (10 per pack) for use with alarm inputs as manufactured by GRI.

F. Audio Visual Alarm (AVA) Devices:

1. A horn and strobe device located at a door for local alarm annunciation.

a. Installed in a 4-inch square box.

2. Approved Product:

a. AV1-LED-024A Strobe/sounder, with Amber Dome 24 VDC (interior/exterior), as manufactured by Federal Signal/

G. KEY MANAGEMENT SYSTEM EQUIPMENT

1. Key Cabinet

a. Approved Product:

1) KD-9-00006 + Data Center Identifier GP-2-0290
2) CC-1-10007 iFOB, Over-moulded, Grey, 128 emboss.

3) CC-1-10041 Self-locking steel cable seals with nylon sleeve, black, 125mm, order of 10 min

2. Ordering Instructions

a. Order Traka key boxes through the closest Traka office supporting the region the project site is located in. traka.com/global/en/about.

3. Power Requirements:

a. Power is hard wired into back of cabinet and connected to an internal power supply, input: 100-240 VAC, output 15 VDC.
b. Power consumption 30 W at 15 VDC maximum
c. Provisions for internal battery-backup, 12 VDC, 3.2 Ah (24-hour duration)

2.2 SITE SECURITY

A. Exterior Security Camera Poles

1. Cameras will be installed to prestressed concrete suitable for direct embedment into the ground without special foundations.

a. Cameras are not to be installed to metal light poles, but lights can be installed on the concrete camera pole. The concrete pole provides stability for the camera in winds.
b. Height of the pole may vary based on devices attached to it with a minimum height of 22 feet (6.7 m).
c. Rated for a minimum of 90 mile per hour wind load with the camera mounted at the top.
d. Shape and Length: Round in cross-section, with a minimum of 7 1/2-inch (190.5 mm) diameter at ground level, and standard taper of 0.125 inch (3.175 mm) per foot. Cross-sectional dimensions are not to deviate by more than 3/8 inch (9.5 mm). Allowable tolerance for overall length tolerance +3 inches (76.2 mm) and -2 inches (50.8 mm).
e. Finish: Smooth uncolored finish with no cracks.
f. Sealing Steel Strands: The end of each steel-reinforcing strand (in the top and butt) burned back to a minimum depth of 1/2 inch (12.7 mm).
g. Cover: Prestressing strands minimum concrete cover of 1 inch (25.4 mm). The centerline axis along the faces of the poles is clear of embedded steel except for stirrups, spiral reinforcement and fabrication devices, so that 3/4 inch (19.2 mm) diameter holes may be drilled without interference from the strands.
h. Pole Cable Entrances: Two cable entrances with couplings cast in poles 90 degrees to the hand hole.

2. At approximately 4 feet (1219 mm) a NEMA 4 and IP 66 for EMEA rated lockable enclosure will be installed to the pole (see Security Drawings for details) with an 8 position PoE switch (see Article 2.6 Security System Network), power supplies, connector block, fiber breakout box, and so on, to support the security devices installed on the pole.

B. Exterior Cameras

1. Specified in this Section in Paragraph 2.5: B.

2.3 VIDEO SURVEILLANCE SYSTEM

A. Video quality definitions:

1. Interior: Target easily seen, a person can be positively identified, no mistake possible.
2. Exterior: Target easily seen, target easily identified as a person and physical features determined, but not positive identification.

B. Exterior Cameras:

1. Fixed:

a. Approved Product:

1) P3267-LVE 5-megapixel single imager camera as manufactured by Axis Communications.

2. Panoramic 180-degree cameras

a. Approved Product:

1) Q3819-PVE 14-megapixel, multi-imager 180-degree camera as manufactured by Axis Communications.

b. Provide a mount suitable for the application.

C. Interior Cameras:

1. Fixed:

a. Approved Product:

1) P3267-LV 5-megapixel single imager camera as manufactured by Axis Communications.

2. 180 degrees panoramic:

a. Approved Product:

1) 3819-PVE 14-megapixel, multi-imager 180-degree camera as manufactured by Axis Communications.

2.4 SECURITY SYSTEM NETWORK

A. Procure Security System Network switches from Anixter.

1. Contact: owen.carey-hatch@anixter.com

B. Security Field Ethernet Switch

1. Approved Product

a. C9300-48P-A, 48 port Ethernet switch as manufactured by Cisco.
b. FTLX1471D3BCL, SFP module for fiber as manufactured by Finisar.
c. PWR-C1-1100WAC, 1100W AC Config 1 Power Supply as manufactured by Cisco.
d. PWR-C1-1100WAC/2, 1100W AC Config 1 Secondary Power Supply as manufactured by Cisco.
e. C9300-NW-A-48 License, C9300 Network Advantage, 48-port license, by Cisco.
f. C9300-DNA-A-48 License, C9300 DNA Advantage, 48-Port Term Licenses, by Cisco
g. C9300-DNA-A-48-3Y License, C9300 DNA Advantage, 48-Port, 3 Year Term License Requested for 36 months and without automatic renewal, by Cisco.
h. PI-LFAS-T License, Prime Infrastructure Lifecycle & Assurance Term - Smart Lic, by Cisco
i. PI-LFAS-AP-T-3Y License, PI Dev Lic for Lifecycle & Assurance Term 3Y, by Cisco Requested for 36 months and without automatic renewal, by Cisco.
j. S9300UK9-169 License, Cisco Catalyst 9300 UNIVERSAL, by Cisco
k. CAB-OPTOUT, Eco friendly green option. No power cable will be shipped by Cisco.
l. C9300-STACK-NONE, No Stack Cable Selected, by Cisco
m. C9300-SPWR-NONE, No Stack Power Cable Selected, by Cisco
n. C9300-SSD-NONE, No SSD Card Selected, by Cisco
o. C1-ADD-OPTOUT, Cisco ONE Add-On Session Opt Out (No Fulfillment), by Cisco
p. NETWORK-PNP-LIC, Network Plug-n-Play Connect for zero-touch device deployment, by Cisco.
q. ADB0039, Adapter, Crossover, Avocent Cyclades to Network Device Console Port, RJ- 45F to RJ-45M, Copper, by Avocent
r. Patch CAT5E, Yellow 7FT, CSC
s. zLockz-C14-14-aC15-3m, Power Cord, 14AWG, Locking C14 Plug to Locking C15 Receptacle, 3m, Black, zLock, C14-C15 Series, by Zonit Structured Solutions, LL

2. Connects to the cameras.

C. Security VMS Server Switch

1. Approved Product (coordinate with Owner):

a. C9300-24 UXB-A, network switch as manufactured by Cisco.
b. FTLX1471D3BCL SFP, module for fiber as manufactured by Finisar.
c. PWR-C1-715WAC, 715W AC Config 1 Power Supply as manufactured by Cisco.
d. PWR-C1-715WAC/2, 715W AC Config 1 Secondary Power Supply as manufactured by Cisco.
e. C9300-NW-A-24, License, C9300 Network Advantage, 24-port license, by Cisco
f. C9300-NW-A-24, License, C9300 DNA Advantage, 24-port Term Licenses, by Cisco
g. C9300-DNA-A-24-3Y, License, C9300 DNA Advantage, 24-Port, 3 Year Term License Requested for 36 months and without automatic renewal, by Cisco.

h. PI-LFAS-T, License, Prime Infrastructure Lifecycle & Assurance, by Cisco
i. PI-LFAS-AP-T-3Y, License, PI Dev Lic for Lifecycle & Assurance Term 3Y Requested for 36 months and without automatic renewal, by Cisco.
j. S9300UK9-1612, License, Cisco Catalyst 9300 XE 16.12 Universal, by Cisco
k. CAB-C15-CBN, Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors, by Cisco
l. C9300-STACK-NONE, No Stack Cable Selected, by Cisco
m. C9300-SPWR-NONE, No Stack Power Cable Selected, by Cisco
n. C9300-SSD-NONE, No SSD Card Selected, by Cisco
o. NETWORK-PNP-LIC, License, Network Plug-n-Play Connect for zero-touch device deployment, by Cisco.
p. C9300-NM-8X, Catalyst 9300 8 x 10GE Network Module, by Cisco
q. ADB0039, Adapter, Crossover, Avocent Cyclades to Network Device Console Port, RJ- 45F to RJ-45M, Copper by Avocent
r. CBL, Patch CAT5E, Yellow 7FT
s. zLockz-C14-14-aC15-3m, Power Cord, 14AWG, Locking C14 Plug to Locking C15 Receptacle, 3m, Black, zLock, C14-C15 Series, by Zonit Structured Solutions, LL

2. Connects the servers together to the Security Core switch.

D. Security Field Ethernet Switch at Pole

1. The security devices at a pole, cameras will connect to a hardened ethernet switch.
2. Approved Product (coordinate with Owner):

a. IE-3200-8P2S-E Industrial Ethernet 3200 Series Switch 10 Ports Managed network switch as manufactured by Cisco.
b. SFP-1GE-LX-US, Rugged SFP module for fiber as manufactured by US Critical
c. PWR-IE240W-PCAC-L=, 240W AC to DC power supply as manufactured by Cisco
d. IOT-OTHER, Not related to an IoT Solution, For tracking only by Cisco.
e. NO-IOT-SOLUTION, Not related to an IoT Solution, For tracking only by Cisco.
f. IE3200-DNA-E, License, Cisco DNA Essentials license for IE3200 Series by Cisco
g. IE3200-DNA-E-5Y, License, IE 3200 DNA Essentials, 5 Year Term license by Cisco

2.5 AUTOMATIC TRANSFER SWITCH (ATS)

A. To support single-cord equipment, the SSFR rack comes equipped with a cabinet automatic transfer switch (C-ATS) preinstalled at RMU 43. The C-ATS has two input cords, input “A” is connected to CPDU “A” and input “B” is connected to CPDU “B”. The C-ATS has eight (8) C13 & one (1) C19 outlets to connect powered equipment. If the primary source becomes unavailable or out of the selected range, the C-ATS will seamlessly source power from the secondary source without interrupting critical loads.

B. Manufacturer: Eaton

1. Part Codes:

a. MPN: EATS220 / APN: 810856 (USA)

b. MPN: EATS16N / APN: 804852 (EUA)
c. MPN: EATS220 / APN: 810856 (JPA)

2.6 WIRE AND CABLE

A. Provided according to Division 27 “Communications.”

B. Power cabling provided according to Section 260519 - Low-Voltage Electrical Power Conductors and Cables

C. Cable is terminated and labeled according to this Section.

D. The following is provided as information only:

1. Access Control System Cable:

a. Cable provided shall be as recommended in writing by card access and security monitoring system manufacturer. No substitutions.
b. Orange or orange/white jacketed composite bundled cables shall be provided from ACM to the doorway.
c. Outside Plant cable (OSP) or other cable that does not come in the desired color shall be marked in the prescribed color, for example, OSP cabling with the appropriate color tape.

2. Video Surveillance System (VSS) Cable:

a. Refer to Division 27 — Communications for horizontal twisted pair cabling requirements. Provide cables with a yellow jacket.

E. Contractor shall be notified as soon as possible of deviations from the above.

2.7 COMPONENT AND WIRE LABELING

A. Approved Products

1. BMP21-PLUS Label maker as manufactured by Brady Corporation: www.bradyid.com or Owner Approved equivalent.

B. Label Material

1. Cable Labeling

a. Brady Part Number: M21-500-499-TB
b. Material Description: Nylon Cloth
c. Color: Black on White
d. Font type: Arial Bold, Size dependent on Cable
e. Brady Material Number: B-499
f. Width: 0.500 inch

2. Component Labeling

    a. Brady Part Number: M21-375-595-YL
    b. Material Description: Vinyl Film with Permanent Adhesive
    c. Color: Black on Yellow
    d. Font type: Arial Bold, Size dependent on Cable
    e. Brady Material Number: B-595

PART 3 - EXECUTION

3.1 INSTALLATION

A. Before the commencement of work, members of the installation team shall become thoroughly familiar with all aspects of the security project and Owner’s requirements.

B. Provide complete installation of components, unless specified as being installed by Others, as follows:

1. Manufacturer's Instructions: Provide, in accordance with each manufacturer's written instructions, installation, enclosures, conduit, wire ways, junction boxes, fiber optic cabling, wiring (including power wiring) and connections for equipment and products specified in this Specification so that each system is complete and fully operational.
2. Rack-mounted card access and security equipment including, but not limited to, ACUs, power supplies, transformers, security monitoring panels, relays and terminal strips will come pre- assembled and delivered in a rack.

    a. Contractor to perform terminations.

3. Provide Security System “Program Load Sheets” and camera VSS license information.

    a. Use Owner-provided template.
    b. Perform this work with Owner's assistance to assure that input parameters, names and information meet Owner requirements and information is correctly entered.
    c. Database loading is defined as anything required to permit proper and complete system operation.

4. Coordinate and verify required conduits, cable trays, pull boxes, back boxes, supports and accessories for a complete and operational security system.
5. Coordinate and ensure power, control and video work required by this Specification is completed in accordance with Division 26—Electrical.
6. Do not disconnect existing systems without written permission from Owner.
7. Coordinate transportation, storage, and work within the facility with Owner to minimize interference, and coordinate work with other trades.
8. Provide required fittings to ensure effective grounding.
9. Install equipment as required for vibration free operation. Provide additional brackets and bracings; provide additional seismic bracing if required by the structural engineer.

C. Reader Interface Modules: Mount the reader interface and door control modules above the associated door in an enclosure.

D. Card Readers

1. Wall mount

a. A back box is required for card readers. Preferably a plastic backbox to best optimize the read range. (Electrical contractor provided; coordinate for proper type.)
b. Check the Security Drawings for the mounting height. Typically, 42 inches (1066 mm) to center above the finished floor (AFF).
c. Make special note regarding separation from other card readers when the readers are installed directly opposite from each other on the same wall.

1) Coordinate with the Electrical Contractor to ensure a horizontal separation of a minimum of 6 inches (203 mm) center to center on an approximately 4.5-inch (approximately 115 mm) wall, can be less if the wall is thicker, prior to rough-in.

d. Wire card reader to access control panel such that:

1) LED red in normal state and turns green when access is granted.
2) Reader sounds short beep when valid card is presented.
3) Reader sounds a long beep when an invalid card is presented.

2. Configuration:

a. Readers are configured with the LED Option 00 which results in:

1) Beep/LED output of Beep on
2) LED normally red
3) Reader flashes green on card read.
4) Each reader is connected to an ACM board and requires Dual Tone.

b. Sequence of Operations:

1) In an idle/normal state, the LED is a solid RED.
2) On a valid card, the LED flashes Green and then back to Red with one short beep.
3) On an invalid card, the LED remains Red with one long beep.

c. The following chart shows the typical wiring connections between the HID reader and USTAR-ACM.

Reader	**RM-4E**
+VDC (RED)	+12V (Read Head Pin 6)
GND (BLK)	Gnd (Read Head Pin 5)

DATA1 (WHT)	D1 (Read Head Pin 1)
DATA0 (GRN)	D0 (Read Head Pin 2)
GRN LED (ORN)	Grn (LED Pin 4)
BEEPER (YEL) RED LED (BRN)	Red (LED Pin 2)

d. DIP Switch Setting:

1) Confirm setting with manufacturer installation instructions.
2) ACM: SW#-1 is ON, and SW3-2 is OFF

3. Card Reader Cable

a. Card readers will require a 6-conductor cable with an overall foil shield (OAFS) which will be used for data and power.
b. The gauge of the wire depends on the distance between the control module and the reader.
c. The cable is run to the MDF. The following chart indicates the proper gauge of the wire and maximum distances where the overall maximum distance of the wire shall not exceed 500 ft (152.4 m).

Gauge (AWG)	**Maximum Length**
22	200 ft (61 m)
20	300 ft (91.4 m)
18	500 ft (152.4 m)

E. Door Contacts:

1. Install according to the manufacturer's installation sheet and door type.
2. The door position switch is placed on the top of the door, approximately 8 inches (203 mm) from the latched side of the door.
3. Alarm Switch Supervision (applies to alarm producing devices):

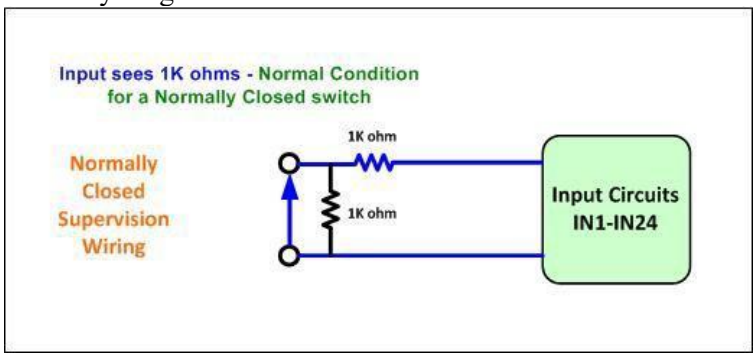
a. All inputs to the ACS shall be wired with end of line resistors to monitor tampering with the wires.

1) The typical resistor pack is the GRI 6644-1. For normally closed wiring the black leads are wired to the device and blue leads go towards the panel.

b. All resistors shall be soldered and shrink wrapped in or as close to the device as possible in a secured location.
c. Do not use door position switches with external mounts.
d. All input devices shall be wired in a normally closed configuration.

e. The following is a list of resistances and the corresponding status that will be reported when detected by the controller:

1) 0Ω (short) - Tamper
2) 500Ω - Alarm
3) 1kΩ - Normal
4) 2kΩ - Alarm
5) Greater than 12kΩ (open) - Tamper
6) Everything else - Line Fault



NC Wiring

F. Local Audible Visual Alarms

1. Owner shall program the AVA through the C-Cure system.

G. Alarm Reporting:

1. All alarm generating inputs will have an End of Line resistor (EOL).
2. Provide waterproof connections to door switches and associated components.

H. Electrified Door Hardware:

1. Provide installation of card access power boosters provided by Finish Hardware Contractor.
2. Provide wiring from electric power door assist push plates to associated ACM as indicated.
3. For doors with a single card reader connect to the Request-to-Exit (REX) switch in the door hardware.
4. For doors with two card readers (in/out) connect to the Latch Monitoring Switch in the door hardware.
5. Configure access control doors with automatic openers such that the opener push plates will not activate the opener until the door is unlocked.
6. If any, connect fail-safe electrified door hardware properly to Fire Alarm ZAM relay contacts.

   a. Fail-safe door hardware should only be used under special circumstances with Owner approval.

7. Network Switches: Provide fiber optic interfaces as indicated for connection to the core network switch.

I. Camera Install (interior):

1. For cameras associated with a door,

    a. Install the camera according to the manufacturer's instructions to the back boxes previously installed by the electrical contractor at 8 feet (2438 mm).

J. Camera Install (exterior):

1. Cameras should be installed between 12-14 feet above ground level.

    a. Any other height is by exception only and should be indicated on the Drawings.

2. Fiber will be run to camera poles by others, an enclosure containing a hardened 8 port Ethernet switch with POE+ capability and associated power supply will be provided and installed by the Security Installer.

    a. At a minimum, exterior cameras will have a heater or be rated for cold weather operation.
    b. Electrical will provide power to the pole for the camera and associated components.
    c. The enclosure will be mounted about 48 inches (1219 mm) from the ground level on the pole.

K. Exterior Camera Spun Concrete Poles:

1. The typical camera pole is made of spun concrete to reduce pole sway in windy conditions.

    a. If the camera poles are made of other than spun concrete, notify Owner's Representative through the Project Manager before installing equipment.

2. Trowel the top surface of each pole until projections, depressions, and irregularities have been removed and the entire surface has a smooth texture and neat lines.
3. Tool square corners and sharp edges to form smooth, chamfered corners.
4. Clean, saturate with water small cavities and then fill with mortar. A small cavity is defined as one larger than 1/4 inch (6.35 mm) but smaller than 3/4 inch (19.05 mm) in diameter, and less than 3/8 inch (9.525 mm) deep.
5. Repair larger non-structural cavities and spalls by opening the side of the damaged area on a 1 to 1 slope using a mechanical grinder, cleaning thoroughly and filling with a high-strength non- shrink concrete repair material.
6. Thoroughly clean holes left by the removal of the sealing steel strands of loose residue. Completely fill holes with non-shrink grout and smooth evenly with tip or butt surface.
7. Poles with other defects may be repaired only upon authorization of, and using the method prescribed by the Design Engineer.
8. Provide a grounding rod unless different grounding methods are shown on the electrical Drawings.

L. Wire and Cable

1. Install Security System related wiring in its own dedicated conduit, unless otherwise indicated.

2. Use color-coding throughout using the same colors as existing systems (if applicable) at the site.
3. Do not run low-voltage cable and wiring in the same conduit as power wiring.
4. Neatly bundle and permanently attach to cabinet interior wiring run within equipment enclosures, wireways or cabinets.
5. Route security system wiring through secure areas to the extent possible.
6. Install security system wiring in non-secure areas in conduits. Route conduit to minimize runs.
7. Size power wiring runs from low voltage power supplies to VSS camera equipment such that voltage drop does not exceed the VSS equipment manufacturer's requirements.
8. Provide separate runs from low voltage power supplies to each camera location. The use of one pair of wires to power more than one (1) camera is not acceptable.
9. Terminate Category 6 cables to a jack in a patch panel on the rack end and to a jack in a "biscuit" at the camera end.
10. Do not exceed industry standard or Manufacturer recommended cable lengths for the type of cable used.
11. Install surface mounted security system cabling below 12 feet (3657.6 mm) AFF in EMT conduit.
12. Security system cable installed inside of walls up to 12 feet (3657.6 mm) AFF may use flex conduit or metal-clad cable.
13. Security system cable installed 12 feet (3657.6 mm) AFF or higher shall:

    a. Use approved j-hooks.
    b. Not sag more than 6-inch (152 mm) hook to hook.
    c. Re-enter conduit at any time the cable breaches a low security zone and/or drops below 12 feet (3657.6 mm).

14. Provide sufficient service loop to installed equipment. Equipment installed in racks shall slide out without disturbing terminations.
15. Install above ground cable in rigid conduit, provided by others.
16. Subsurface cable shall be fiber cable unless approved by Owner and is water resistant and run in conduit all provided by others.
17. Network cable extenders shall not be used.

    a. When the network cable extends beyond the maximum allowable, fiber will be used to increase the signal distance.

M. Wire Splicing:

1. General:

    a. Use high quality wire stripping tools.

        1) Avoid nicking wire.

    b. Wire inserted into terminal blocks are tinned.
    c. Wire splices are soldered and covered with shrink tubes.

        1) Solder sleeves are allowed.
        2) Straight through terminal blocks are allowed.

d. No other method of splicing, such as wire splicing beans, will be allowed. These splicing methods shall be applied to wire joints to include wire to wire, resistor packs, pigtails, and so on.
e. Avoid having to splice cables due to insufficient length.
f. If cable needs to be spliced, it will be done in a 4 inch (101.6 mm) minimum square electrical box.

2. When wire splicing is required:

a. A feed-through terminal block may be used, such as a Phoenix Contact feed-through terminal block sized for the box and number of wires to be connected.
b. Or instead of using a feed through terminal block, the solder with heat shrink tubing method shall be used.

1) There are no alternative methods to solder and heat shrink tubing.

a) The use of wire nuts, splice “Beans,” twisting the wire together (not soldered) and taped or heat shrink), solder and electrical taped (or anything other than heat shrink), shall not be used and will require the splice to be redone.

2) The installer will select and use the proper conductor preparation tools:

a) Strippers.

- Precision mechanical tools will be used for insulation stripping.
- The tools shall not nick, ring, gouge, or stretch conductors or remove plating so that the base metal shows.
- Superficial scraping of conductors is acceptable providing conductor base material is not exposed.
- Example: Irwin-Vice Grip Wire Stripper, Jokari Soft Grip.

b) Wire Cutters.

- Wire cutting tools that shear the conductor will be selected in preference to diagonal cutters that cut the conductor by bringing two blade edges together.
- The cutting edges of wire trimming tools will be maintained sharp and free from nicks and indentations.
- Example: Xuron 440 High Precision Scissor, Xuron 2175 Maxi-Shear Flush Cutter.

c) Heat-Shrinkable Sleeving.

- The heat-shrinkable sleeving selected will be larger than the maximum diameter of the object being covered, and after shrinking it will provide a tight fit over the object in the area of maximum diameter.
- This will cause the sleeving to have a tight mechanical grip on the item it covers.
- There will be no partially or incompletely shrunken areas.
- Sleeving may have a slight surface crazing, but it will be free of cracks, punctures, and charred or burned areas.

d) Stripping Round Conductors Insulated wires will be prepared in accordance with the following requirements:

3) Insulation Removal.

a) Stripping tools, used to remove conductor insulation will be of the correct size and in correct adjustment and/or calibration.
b) The stripping tools will be in compliance with subparagraph 3.1: N2b.2).a).

4) Damage to Insulation.

a) After removal of the insulation segment, the remaining conductor insulation will not exhibit damage such as nicks, cuts, or crushing.
b) Conductors with damaged insulation will not be used.
c) Scuffing from mechanical stripping is acceptable.

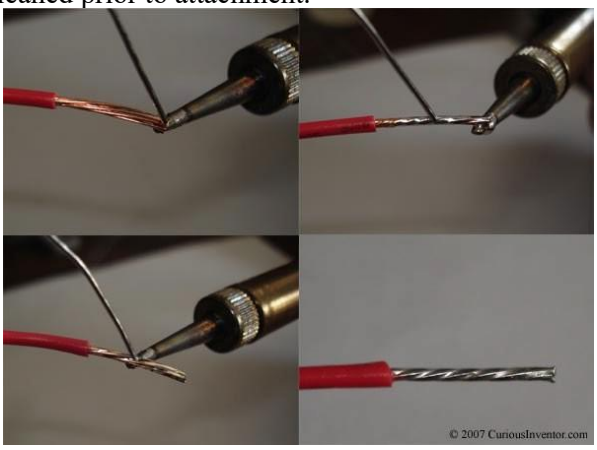
5) Damage to Conductors.

a) After removal of the conductor insulation, the conductor will not be nicked, cut, or scraped to the point that base metal is exposed.
b) Conductors that were reduced in the cross-sectional area will not be used.

c) The lay of wire strands (the direction of twist of the individual wire strands) will be restored as close as possible to the original lay if disturbed by twisting the wire with the fingers in the direction of the lay.

6) Tinning of Conductors for Splicing.

a) Before wires are inserted into terminal blocks such as Phoenix connectors or the connector strips on the circuit boards, they will be properly tinned.
b) The portion of stranded wires that will eventually become a part of the finished solder connection will be coated with tin-lead solder and cleaned prior to attachment.



c) Additional flux may be used.
d) The flux will be applied so that it does not flow under the insulation except for traces carried by solder wicking.
e) Flux will be removed with cleaning solvent applied so that its flow under the conductor insulation is minimal (by avoiding use of excessive solvent and positioning the conductor so that the gravity keeps the solvent from flowing under the insulation).
f) Flow (wicking) of solder along the conductor is permitted but will not mask the conductor strands at the termination end of the insulation.

7) Stripping Jackets Over Shields.

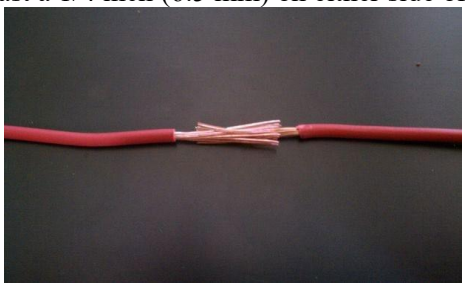
a) Jackets over shields are stripped by mechanical means.
b) Nicked shield strands will not exceed 10 percent of the total number of strands.
c) There will be no severed strands.
d) After removal of the insulation segment, the remaining conductor insulation will not exhibit damage such as nicks, cuts, or crushing.
e) Scuffing from mechanical stripping is acceptable.

3. Wire Splicing method 1

a. Use of a “Heat Shrink Sleeve Solder Butt Connector” is recommended to save splicing time.

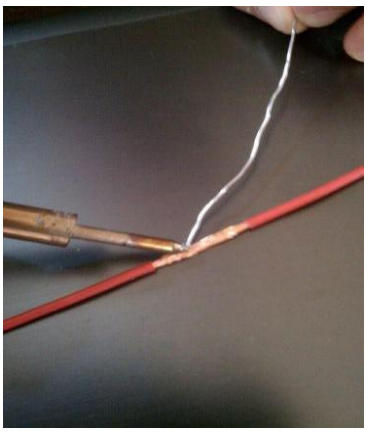
1) It is a shrink tube containing solder where upon the wires are inserted into both ends and heat applied, melting the solder, and shrinking the tube for a tight, soldered connection.

a) Prior to joining the wires slide a piece of heat shrinkable sleeving sized to the wire being spliced, and long enough to cover the splice plus at least a 1/4 inch (6.5 mm) on either side of the spliced wire.



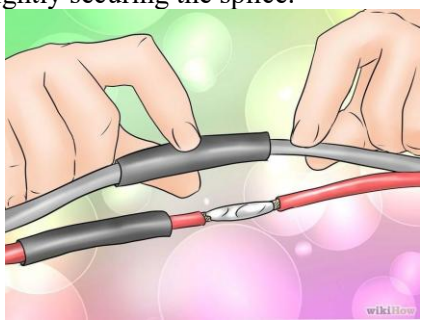
b) Push the wires so they intermingle with one another.
c) Conductors shall not overlap the insulation of the other wire.
d) Slightly twist the wires to gather the protruding wires.

e) Solder shall wet all elements of the connection.



f) The solder shall filet between connection elements over the complete periphery of the connection.

g) Slide the heat shrink sleeve over the splice and heat with a heat gun tightly securing the splice.



4. Wire Splicing Method 2

a. Same as above except the wires are twisted together in a more secure manner.
b. The conductors shall be pre-tinned.
c. Prior to joining the wires slide a piece of heat shrinkable sleeving sized to the wire being spliced, and long enough to cover the splice plus at least a 1/4 inch (6.5 mm) on either side of the spliced wire.

d. There shall be at least 3 turns around each conductor and the wraps shall be tight with no gaps between adjacent turns.
e. The wraps shall not overlap, and the ends of the wrap shall be trimmed flush before soldering to prevent protruding ends.
f. Conductors shall not overlap the insulation of the other wire.
g. Solder shall wet all elements of the connection.
h. The solder shall filet between connection elements over the complete periphery of the connection.
i. Slide the heat shrink sleeve over the splice and heat with a heat gun tightly securing the splice.

N. Cabinet Wiring and Terminations:

1. When within the back of the iStar, the cabling will run parallel to the terminals to which they will connect.
2. Feed each wire (or wires) from the cable at a 90-degree angle to the terminal. Tie-wrap the cable and continue in that manner until each wire is connected.
3. There should be a tie-wrap between each wire as it bends in line to the point at which it connects.
4. The cable within the cabinet will run in parallel to the sides of the cabinet with all bends being at right angles.
5. Acceptable Installation Examples

O. Cameras

1. Mount interior fixed cameras on the swing side of the doorway at 8 feet-6 inches (2590 mm) above the finished floor or mounted above the doorway on exit path from the secure area. See Drawings for exact location.
2. Position cameras such that they provide coverage of at least 3 steps of a person approaching a door and provide sufficient image quality to recognize the gender and general features of the person and facial recognition.
3. The 24 V power supply units for heaters and blowers may be local to security cameras.
4. Provide dedicated circuits for heaters and blowers.

P. Exterior Camera Poles

1. Trowel the top surface of each pole until projections, depressions, and irregularities have been removed and the entire surface has a smooth texture and neat lines.
2. Tool square corners and sharp edges to form smooth, chamfered corners.
3. Clean and saturate with water small cavities and then fill with mortar. A small cavity is defined as one larger than 1/4 inch (6.35 mm) but smaller than 3/4 inch (19.1 mm) in diameter, and less than 3/8 inch (9.55 mm) deep.
4. Repair larger non-structural cavities and spalls by opening the side of the damaged area on a 1 to 1 slope using a mechanical grinder, cleaning thoroughly and filling with a high-strength non- shrink concrete repair material.
5. Thoroughly clean holes left by the removal of the sealing steel strands of loose residue. Completely fill holes with non-shrink grout and smooth evenly with tip or butt surface.
6. Poles with other defects may be repaired only upon authorization of, and using the method prescribed by the Design Engineer.

7. Provide a grounding rod unless different grounding methods are shown on the electrical Drawings.

Q. Coordination with other Trades through the Contractor

1. Fire alarm system:

   a. Coordinate work with the fire alarm system provider.
   b. Security hardware to revert to mechanical operation during fire alarm events. Such events only allow people to go only from secure to less secure areas.

2. Security Door Hardware, Locks, Boosters, and Electric Operators

   a. Review the door hardware schedule in Architectural Drawings and Section 087100 - Door Hardware.
   b. Coordinate operation of door security hardware with the local AHJ if needed.
   c. Coordinate location of power boosters and electric door components with Finish Hardware Contractor.
   d. Coordinate with hardware suppliers required electric lock voltages and maximum current levels of equipment-requiring interface with Card Access and Video Surveillance System.

3. Camera Placement:

   a. In areas of VSS camera surveillance coordinate modification of the quantity and location of lighting fixtures as required after the installation of cable trays, cabinets, and other equipment is completed, with the lighting contractor.
   b. Coordinate work, including but not limited to location of lighting fixtures with Division 26 Contractors. Verify final lighting fixture layout assures that the uniformity and illumination levels in monitored areas is adequate for security system operation.
   c. Coordinate location of exit signs and security video cameras above doors to avoid space conflicts and to assure code-required location of exit signs and proper operation of cameras.
   d. Coordinate rough-in for camera locations shown on the Drawings with the electrical subcontractor.
   e. Verify locations with architectural reflected ceiling plans prior to rough-in to account for line-of-sight obstructions.

4. Field verify secure openings for proper frame preparations and raceway, rough in prior to wall close.
5. Cabling:

   a. Coordinate with Contractor to ensure cable is being installed in a timely manner.

6. Lighting and lighting controls

   a. Lighting shall meet minimal requirements as established by the Illuminating Engineering Society of North America for exterior and interior applications, and for

effective Security Video System deployment. Refer to Section 265100 - Lighting for lighting levels.

b. Refer and coordinate design with lighting controls.

c. For lighting levels, refer to Electrical Design Guide Part C, Table 2: Outdoor lighting Power Density & Illuminance Levels.

3.2 SYSTEM LABELING

A. Provide labeling and numbering required for components and wiring.

B. Follow Owner's labeling format. Refer to Section - OPR - OneGDC Naming Standard-(UID:46283)

C. Submit sample label format to Owner for approval before actual install of labels.

D. Individually label each terminal block and terminal in each cabinet, rack, or panel.

E. Individually label each wiring conductor connected to terminal blocks and each final device at each end.

F. Individually label each cable or wiring group being extended from a panel or cabinet to a building-mounted device with the number or name of a particular device at each end of cable or wiring group.

G. Each wire conductor connected to a building-mounted device is not required to be numbered at device end if color of wire is consistent with associated wire connected and numbered within panel or cabinet.

H. Number fiber optic cables at each end of each cable. Provide numbering to identify cable number and camera associated with cable.

I. Provide permanent type labels designed for intended use.

J. Painting of numbers on panels or equipment is not acceptable.

K. Use of embossed stick-on labels is not acceptable.

L. Provide labeling for VSS and ACS field interface panels as previously specified.

M. Label cables and wires at time of installation.

N. Label cable on each end as follows:

1. Security Camera CAT6 cabling (YELLOW).

    a. CAT6 - Patch Cable labeling.

2. ACS Cabling (ORANGE)

    a. Site ID

b. Floor #
c. Door # - Unique Sequential door Number or a number that is associated with a room number.
d. MDF Rm # Unique Sequential IDF Number where terminated.
e. iSTAR Unique Port # in brackets where terminated. Example (Use project site ID): SLN3A 1-100 IDF1-1[1.1.1.1]

    1) Site ID = SLN3A
    2) Floor # 1
    3) Door # = 100
    4) MDF # 1.1 = IDF1-1
    5) [Istar#.Acm#.CommPort#.ReaderPort#] = [1.1.1.1]

f. iSTAR to Corporate Network Switch Cable (Orange)

    1) Use wrap around labels and write SOURCE and DESTINATION in brackets of patch lead onto both ends multiple times (generally finds place 4 times)
    2) Site ID
    3) Source - Unique iSTAR #
    4) Destination - CorpSwitch and Port ID in brackets where terminated (Assign by Client)
    5) Example (use project site ID): SLN3A iSTAR1-1-1 [ACCSW1-1-1:48]

        a) Site ID = SLN3A
        b) Source = iSTAR1-1-1 (IDF 1.1 = 1-1, Unique iSTAR 1)
        c) Destination = [ACCSW1-1-1:48]

O. Equipment Labeling, label each piece of security equipment as follows:

1. iSTAR/GCM

    a. Site ID
    b. MDF # Unique Sequential MDF Number where terminated.
    c. Unique iSTAR # Unique Sequential iSTAR number.
    d. CorpSwitch and Port ID in brackets where terminated (Assign by Client)
    e. Example (use project site ID): SLN3A iSTAR1-1-1 [ACCSW1-1-1:48]

        1) Site ID = SLN3A
        2) MDF # 1.1 = 1-1
        3) iSTAR # = 1
        4) [CorpSwitch#:Port# in brackets] = ACCSW1-1-1:48

2. CARD READER

    a. Site ID
    b. Floor #
    c. Door # Unique Sequential door number or a number that is associated with a room number.
    d. iSTAR Unique Port #
    e. Example (use project site ID): SLN3A 1-100 [1.1.1.1]

1) Site ID = SLN3A
2) Floor # = 1
3) Door # = 100
4) [Istar#.Acm#.CommPort#.ReaderPort# in brackets]= 1.1.1.1

3. VIDEO SECURITY MANAGED SYSTEM SWITCH

a. Site ID
b. Switch Type (Security Managed Systems Access Switch - SMSACC, Security Managed Systems Aggregation Switch - SMSAGG, Security Managed Systems Server Switch - SMSSRV)
c. MDF #
d. Switch # Unique Sequential Switch number
e. Security Managed Systems Switch name and Port ID in brackets where terminated.
f. Example (use project site ID): SLN3A SMSACC1-1-1 [SMSAGG1-1-1:24]

1) Site ID = SLN3A
2) Switch Type = SMSACC
3) MDF 1.1 = 1-1
4) Switch # = 1
5) [SwitchName:Port# in brackets] = [SMSAGG1-1-1:24]

4. CAMERA

a. Site ID
b. Floor #
c. Room # Associated with the Camera
d. Camera # Unique Sequential Camera number
e. Security Managed Systems Switch name and Port ID in brackets where terminated.
f. Example (use project site ID): SLN3A 1-100 CLDK-01-01 [SMSACC1-1-1:24]

1) Site ID = SLN3A
2) Floor # = 1
3) Room # = 100
4) Camera # = CLDK-01-01
5) Switch name:Port # = [SMSACC1-1-1:24]

5. AVA/LDA

a. Site ID
b. Floor #
c. Door # associated with AVA/LDA
d. iSTAR Unique Port # in brackets where terminated.
e. Example (use project site ID): SLN3A 1-100 [1.1.1]

1) Site ID = SLN3A
2) Floor # = 1
3) Door # 100
4) [Istar#.Acm#.Port#] = 1.1.1

6. iCAM

    a. Site ID
    b. Floor #
    c. Room # Associated with the iCAM
    d. CorpSwitch and Port ID in brackets where terminated (Assign by Client)
    e. Example (use project site ID): SLN3A 1-500 [ACCSW1-1-1:48]

        1) Site ID = SLN3A
        2) Floor # = 1
        3) Room # = 500
        4) [CorpSwitch#:Port# in brackets] = ACCSW1-1-1:48

7. ACS POWER SUPPLY

    a. Site ID
    b. Istar # associated with Power Supply
    c. Power Supply # : and Voltage (1A:12v or 1B:24v)
    d. Example (use project site ID): SLN3A iSTAR1-1-1-1A:12v

        1) Site ID = SLN3A
        2) iSTAR # = iSTAR1-1-1
        3) PS # : Voltage = 1A:12v

3.3 TESTING AND COMMISSIONING

A. Refer to Section 280800 for testing and commissioning requirements.

END OF SECTION 281300

SECTION 283105 - FIRE ALARM CABLES AND PATHWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. Section includes:

1. Fire alarm cables.
2. Fire-resistive fire alarm cables.
3. Fiber optic cables for fire alarm.
4. Fire alarm terminal cabinets.
5. Fire alarm raceway and boxes.

1.3 DEFINITIONS

A. Dedicated Continuous Metal Raceway: Enclosed metal pathway dedicated to power-limited fire alarm cable, comprised of and limited to EMT, IMC, RGS, FMC, and/or LFMC as specified.

1.4 SUBMITTALS

A. Comply with Division 28 for “Pre-installation Submittals”.

B. Product Data: For each fire alarm cable application, including cable type, wire size, shielding, and electrical characteristics.

1. Include statement from manufacturer’s authorized representative that the electrical characteristics of the submitted fire alarm cables are within all operating parameters of the fire alarm system as designed and represented by the detailed fire alarm system shop drawings.

C. Product Data: For fire alarm terminal cabinets, including furnished options and accessories.

D. Record of Inspection and Testing: For field wiring inspection and testing; for each circuit indicate measured values and corresponding acceptance criteria for circuit continuity, resistance, stray voltage, ground-faults, short-circuit-faults, and any other manufacturer recommended conductor field testing parameters.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authority having jurisdiction, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 FIRE ALARM CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden Inc.
2. Southwire Co.
3. West Penn Wire

B. Multi-conductor Metal-clad Cable: UL 1424, Type MC-FPLP, power-limited fire alarm cable; jacketed, twisted-pair solid copper conductors with aluminum interlocking outer armor jacket; unshielded and shielded.

C. Multi-conductor Cable: UL 1424, Type FPL, FPLR AND FPLP power-limited fire alarm cable; jacketed, twisted-pair solid copper conductors; unshielded and shielded.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Red Alert MC- FPLP cable, manufactured by Southwire Co.

D. Signaling Line Circuits: Twisted pair, size as recommended by system manufacturer.

E. 16 AWG wire size minimum, with voltage drop no greater than 3.0 volts.

F. Minimum Fire Alarm Cable Conductor Size:

1. Auxiliary (24 Vdc) Power: 14 AWG / 2C.
2. Data Communications Network: 16 AWG / 2C.
3. Digital Voice Riser: 16 AWG / 2C.
4. Notification Appliance Circuits: 14 AWG / 2C.
5. Relay Circuits: 14 AWG / 2C.
6. RS Serial Data Communications: 18 AWG / 2C.
7. Signaling Line Circuits: 16 AWG / 2C.
8. Speaker Circuits: 16 AWG / 2C.
9. Supervision Circuits: 16 AWG / 2C.
10. VESDA Network: 24 AWG / 2C.

G. Data and Voice Circuits:

1. Fire alarm cable for data communications network, digital voice riser, signaling line circuits, speaker circuits, RS serial data communications, and other manufacturer-specific

data and voice circuits shall be shielded, twisted-pair unless fire alarm manufacturer's installation guidelines recommend or require unshielded twisted-pair cable.

2. Fire alarm cable electrical characteristics for data communications network, signaling line circuits, RS serial data communications, and other manufacturer-specific data circuits shall comply with the fire alarm manufacturer limitations for linear-unit and total- circuit capacitance and resistance.

2.2 FIBER OPTIC CABLES FOR FIRE ALARM

A. Manufacturers: Subject to compliance with requirements, provide products by for the following:

1. Corning Incorporated; Corning Cable Systems.

B. Single-mode, 12-strand minimum cable; with performance characteristics to satisfy fire alarm system manufacturer requirements for digital network and voice applications.

1. Comply with Owner requirements for fiber type and connectors. Refer to Division 27 specifications.

C. Fiber Optic Jumper Cords:

1. All fiber optic jumper cords shall be factory-made. Field-constructed fiber optic jumper cords are not acceptable.
2. Fiber optic cable shall match type and be compatible with fire alarm control unit connections and the patch panel connections.

D. Fiber Optic Cable Hardware:

1. Meet the Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA- 604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

a. Connecting hardware shall match type and be compatible with fire alarm control unit connections and the patch panel connections.
b. Insertion loss not more than .75 db.

E. Fiber optic cable and connections shall match owner's standards refer to Division 27.

2.3 FIRE ALARM TERMINAL CABINETS

A. Enclosure: 16 gauge cold rolled steel factory finished with a durable red, heat-resistant baked-on enamel finish; removable hinged door with keyed locking latch; marked "FIRE ALARM TERMINAL CABINET" in 2" white indelible screened lettering; include embedded 1/2", 3/4", 1", 1 1/2" and 2" knockout clusters.

B. Terminals: Dual 16-point high barrier terminal strips rated for 12 gauge wire and 20 amp max 250V (Class B/UL) 300V (CSA); terminal strips mounted on 18 gauge cold rolled steel galvanized finish backboard and secured to the back box.

C. Identification: Marked “FIRE ALARM TERMINAL CABINET” in 2-inch white factory applied indelible screened lettering; field identification labels on the inside cover corresponding to the terminal strip’s labeling inside the back box.

2.4 FIRE ALARM RACEWAY AND BOXES

A. Comply with Division 26.

1. Finish: Factory applied red finish for raceway, boxes, cover plates, connectors, and similar.

B. A minimum conduit size of ¾” shall be utilized.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with NFPA 70 and NFPA 72.

B. Unless more restrictive requirements are noted in Division 28, comply with applicable Division 26 sections for the installation of low voltage electrical systems.

3.2 NFPA 72 FIRE ALARM PATHWAY DESIGNATIONS

A. Install pathways in accordance with the following NFPA 72 designations for Class (operation under fault conditions) and Level (survivability under fire exposure):

1. Addressable Signaling Loops: Class A, Level 0 and/or 1.
2. Audible and Visible Notification Appliance Circuits: Class B, Level 0 and/or 1.
3. Communications (Data and Voice) Between Network Nodes: Class X, Level 1.
4. Supervision of Conventional Devices: Class B, Level 1.
5. Fail Safe Operation: Class D, Level 1.

B. Unless greater distances are indicated on the drawings or specifications, install Class A and X pathways in compliance with NFPA 72 recommendations for minimum horizontal and vertical separation between supply and return pathways.

C. Supply and return fire alarm pathways entering / exiting buildings within underground duct banks shall be located in separate duct banks. Where only one (1) duct bank is available, locate pathways within separate conduits located in the single duct bank with the maximum possible separation distance permitted by the duct bank geometry.

3.3 FIRE ALARM CABLE AND PATHWAY INSTALLATION

A. Pathways for Fire Alarm: The pathway system for fire alarm shall be dedicated, continuous metal raceway throughout. Comply with Division 26 for application and installation of EMT, IMC,

RGS, FMC, and LFMC with respect to environmental conditions and resistance to physical damage.

1. MC fire alarm cable is permitted with owner approval within concealed construction.
2. FPLP supported by dedicated J-hook system is permitted with owner approval above suspended tile ceilings.

B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. T-tapping: Not permitted for any fire alarm circuit.

E. Do not use ganged boxes for fire alarm.

3.4 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 283105

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. Section includes:

1. Fire-alarm control units.
2. Emergency voice communication system.
3. Local operating consoles.
4. Digital alarm communicator transmitter.
5. IP communicators.
6. Remote power supplies.
7. Manual fire-alarm boxes.
8. System detectors.
9. Notification appliances.
10. Addressable interface modules.
11. Fault isolation modules.
12. Network communications.
13. Magnetic door holders.
14. Transient voltage surge suppressors.
15. Maintenance bypass switches.
16. Device guards.
17. Fire document box.

1.3 DEFINITIONS

A. ADS: Acoustically Distinguishable Space.

B. AHJ. Authority Having Jurisdiction.

C. BMS: Building Management System.

D. EVACS. Emergency Voice Alarm Communication System.

E. FACU: Fire Alarm Control Unit.

F. FATC: Fire Alarm Terminal Cabinet.

G. HLI: High Level Interface

H. IDC: Initiating Device Circuit.

I. NAC: Notification Appliance Circuit.

J. NICET: National Institute for Certification in Engineering Technologies.

K. PC: Personal computer.

L. SLC: Signaling Line Circuit.

1.4 SUBMITTALS

A. Comply with Division 23 and Division 26 for common mechanical/electrical requirements.

B. Comply with Division 28 specifications and drawings; state/local regulations; and NFPA 72 - Chapter "Documentation". For purposes of applying NFPA 72, all identified documentation requirements are a mandatory part of the work, including those that "apply only where required by other governing laws, codes, or standards, by other parts of the code; or by project specifications or drawings".

C. Submit "Pre-installation Submittals" prior to applying for authority having jurisdiction installation permits (where required) and system installation.

D. Submit "Approval Testing Submittals" after successful initial system testing and prior to scheduling authority having jurisdiction final approval demonstration testing.

E. Submit "Closeout Submittals" as part of project closeout procedure.

1.5 PRE-INSTALLATION SUBMITTALS

A. Qualification Data: For designers and field technicians.

1. Include NICET certifications and fire alarm system manufacturer training certifications.

B. Product Data: For each type of product, including furnished options and accessories.

1. Include approvals and listings, construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.
3. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements of this specification and of NFPA 72.

C. Seismic Qualification Certificates: For fire alarm control unit, accessories, and components, from manufacturer.

1. Basis of Certification: Indicate whether withstand certification is based on actual tets of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Sample Warranty: For special warranty.

E. Shop Drawings: For fire alarm system and fire safety control interfaces.

1. Floor Plans. Include floor plans to indicate final equipment, cabinet, device and appliance locations. Indicate address of each addressable device. Show all interface modules. Show candela setting for each strobe appliance. Show complete point-to-point routing of all circuits and pathways; indicate Class and Survivability Level. Show size and type of all conduits, cable, wire, and conductors. Indicate panel circuit designation for each normal power supply branch circuit.
2. Riser Diagram. Include complete device/appliance accurate riser diagram. Indicate address of each addressable device. Show all interface modules. Show candela setting of each strobe appliance. Show each circuit and pathway; indicate Class and Survivability Level. Show size and type of all conduits, cable, wire, and conductors. Indicate panel circuit designation for each normal power supply branch circuit.
3. Equipment Wiring Diagrams. Include wiring diagrams for each system component/node including control unit cabinets, remote power supply cabinets, terminal cabinets, remote annunciators, supervising station transmitters, and PC workstations.
4. Component Wiring Diagrams. Include typical wiring diagrams for fire detector bases, pull stations, conventional devices, interface modules including wiring connections to supervised/controlled equipment, notification appliances, and component modules and cards.
5. Ductwork Smoke Detector Plans. Include installation details for each ductwork detector condition. Show plan and section view for each condition. Show requirements for ductwork attachments, penetrations, and access panels.
6. Calculations - Voltage Drop. Include voltage drop calculations inclusive of safety/spare capacity factor(s) for notification-appliance circuits. Calculations shall assume alarm operation using the minimum standby power available at the conclusion of quiescent and alarm phases of operation.
7. Calculations - Power Supply and Battery Capacity. Include power capacity calculations inclusive of safety/spare capacity factor(s) for each system power supply and connected battery set.
8. Calculations - Conduit Fill. Include conduit fill calculations prepared in accordance with the National Electric Code.
9. Sequence of Operation. Include complete and detailed input/output sequence of operation matrix. Supplement matrix with narrative descriptions for complex specialty sequences.
10. Emergency Voice/Alarm Communication Systems; additionally:

    a. Floor Plans. Indicate amplifier equipment cabinets, primary and remote paging locations, and associated circuits and pathways. Show wattage tap and corresponding ADS for each speaker. Indicate circuit pathway Class and Survivability Level.
    b. Equipment Wiring Diagrams and Component Wiring Diagrams. For amplifier racks, remote microphone stations, and speaker appliances.
    c. Amplifier Loading. For each speaker circuit, identify quantity of speakers at each wattage tap setting and total connected wattage per circuit and per amplifier.

Demonstrate calculated loading inclusive of safety/spare capacity factor(s) is accommodated by amplifier nominal power (watts) capacity.

d. Audio dB Loss Calculations. For each speaker circuit.
e. Power Supply Battery Capacity Calculations. For each amplifier array power supply and connected battery set, inclusive of safety/spare capacity factor(s).

1.6 CLOSEOUT SUBMITTALS

A. Record of Completion. Provide detailed description of installed, tested, and approved fire alarm and signaling system; including description of protected premises, fire alarm system and component sub-systems, fire safety function interfaces, monitoring service, and all other information required by NFPA 72. Use NFPA 72 “System Record of Completion” forms.

B. Record Drawings. Provide complete shop drawing re-submittal updated to reflect actual final system installation and sequence of operation of all components.

C. Device Address List. Provide complete device address list organized by SLC loop and system node.

D. Operation and Maintenance Data: For fire alarm systems and components to include in emergency, operation, and maintenance manuals.

1. Provide manufacturer's owner’s operation and maintenance manuals with required related system warranty requirements.
2. Provide print out of all the system type detectors sensitivity compensation head room range.
3. Provide NFPA 72 “Inspection, Testing, and Maintenance” tables indicating required component inspection and testing activities and frequencies.
4. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

E. Software and Firmware Operational Documentation:

1. Provide software operating and upgrade manuals.
2. Site-specific Software Backup: Provide on compact solid state USB storage device or compact disk; complete with data files.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Smoke Detectors and Heat Detectors: Three (3) of each type installed.
2. Detector Bases: Three (3) of each type installed.
3. Audible and Visual Notification Appliances: Three (3) of each type installed.
4. Keys, Tools and Hand-held Programmers: One extra set for access to locked or tamper-proof components.

5. Fuses: Two (2) of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.8 QUALITY ASSURANCE

A. Field Technician Qualifications: Personnel trained and certified by fire alarm system manufacturer as an approved technician.

B. Designer Qualifications: Shop drawings and Calculations prepared by personnel certified by NICET as fire alarm Level III or IV technician.

C. Source Limitations for Fire Alarm System and Components: Single vendor source to provide fire alarm system components and connected non-system components as a single listed addressable fire alarm and signaling system.

1. Modifications to Existing Systems: Components compatible with, and operate as an extension of, existing system.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1. Specific Agency Requirements for All Products: Underwriters Laboratories (UL) listed and Factory Mutual (FM) Approved.

E. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.9 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify construction manager and owner no fewer than ten (10) days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without written permission from construction manager and owner.

B. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.10 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to owner to allow scheduling and access to system and to allow owner to upgrade computer equipment if necessary.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five (5) years from the first day of business.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design: Edwards Systems Technologies (EST); a United Technologies Corp. Company.
2. Notifier; a Honeywell company.
3. Siemens Building Technologies, Inc.; Fire Safety Division.
4. Where the site fire alarm monitoring network is part of a proprietary supervising station fire alarm system, provide products by the same manufacturer as the proprietary supervising station fire alarm system head end and command workstation.

B. Where additional manufacturer listings or basis of design products are indicated, provide products listed and duty rated as compatible with the selected fire alarm and signaling technology platform.

2.2 SYSTEM DESCRIPTION

A. UL 864; non-coded, microprocessor-based addressable protected premises fire alarm and signaling system, with multiplexed signal transmission and audible/visual evacuation signaling. All components provided listed for use and compatible with fire alarm system head-end FACU.

B. Protected premises backbone architecture comprised of multiple fire alarm control units and system components networked via peer-to-peer communications node network.

C. Control units, system components, and power supplies inclusive of boards, drivers, and expansion modules necessary to support the specified system performance criteria, minimum quantity of circuits, and NFPA 72 circuit pathway class designations.

D. All components listed for use with the selected fire alarm system technology platform.

E. System circuiting and component power loading to provide minimum specified spare capacities, safety factors, and redundancies.

F. All addressable circuits designed and installed without T-taps.

G. Fire alarm system listed for combination In-building Emergency Voice Alarm Communications System (EVACS) and Mass Notification System (MNS) service utilizing digital multi-channel technology.

H. Connection to Site Fire Alarm Monitoring and Emergency Communication Systems:

1. Address-specific status reporting of protected premises in-building fire alarm network nodes to the site fire alarm monitoring network.
2. Complete functional integration of protected premises in-building EVACS / MNS and site Emergency Communication System (ECS) permitting messages and signals originating from the site ECS head-end to signal over the protected premises NAC's.

I. Complete end-to-end fire alarm system interfaces with other premises building systems including Fire Suppression, HVAC, Vertical Transportation, Audio/Visual, Public Address, Access Control, Fire Protection Opening Protectives, Emergency Power, and similar for all code-required and project-specified fire safety supervision and functional control.

2.3 PERFORMANCE REQUIREMENTS

A. Operational Performance: Fire alarm system shall process alarm, supervisory, and trouble status signals and perform associated output functions in compliance with NFPA 72, Division 28 and Drawings Input/Output Matrix.

B. Emergency Communication System: Comply with NFPA 72 for combination In-building Emergency Voice Alarm Communications System (EVACS) and Mass Notification System (MNS).

C. Circuit Integrity and Fault Performance: Fire alarm system circuit integrity and functional performance capability under fault conditions shall comply with the NFPA 72 circuit Class designations as specified under Div. 28.

D. Survivability Performance: Fire alarm system fire resistive performance capability shall comply with the NFPA 72 circuit Level designations as specified under Div. 28.

E. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified [and the unit will be fully operational after the seismic event].”

2.4 FIRE-ALARM CONTROL UNIT

A. General: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
2. Include a real-time clock for time annotation of events on the event recorder and printer.
3. Provide communication between the FACU and remote circuit interface panels, annunciators, and displays.
4. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACU shall provide a minimum 500-event history log.

B. Enclosure: Steel, factory-paint red.

1. Mounting: Flush and surface as required by application.
2. Door: Hinged, removable, key-lock; with view window or dead-front for remote node application.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

D. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

E. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.
2. Base Capacity: System operation for twenty-four 24 hours under quiescent load plus fifteen (15) minutes operating all alarm notification appliances.
3. Spare Capacity: 20%.

F. Signaling Line Circuits (SLC):

1. Minimum Quantity: One (1), expandable to ten (10).
2. Minimum Capacity: 125 addressable initiating devices and 125 addressable modules (250 addressable devices total) per loop, expandable to 2500).
3. Configuration: Capable of supporting Class A SLC configuration.

G. Notification Appliance Circuits (NAC)

1. Minimum Quantity: Four (4), expandable to eight (8).
2. Minimum Rating: 24V-dc @ 2.0 Amps
3. Public Mode Audible Operation: NFPA 72 three-pulse temporal pattern.
4. Public Mode Visual Operation: Synchronized, UL 1971 strobe pattern.

H. Auxiliary Power Outputs:

1. Two (2), expandable to five (5) continuous 24V-dc @ 2.0 Amps.
2. One (1) resettable 24V-dc @ 2.0 Amps.

I. Serial Interfaces:

1. RS 485 port(s) for remote annunciators, Ethernet module, or multi-interface module (printer port).
2. USB port(s) for PC configuration.
3. RS 232 port(s) for voice evacuation interface.

J. Smoke-Alarm Verification: Control algorithm(s) permitting smoke detectors to verify alarm obscuration levels upon initial alarm. After verification time period is completed, detector alarm status “latches” if obscuration level remains above alarm threshold or “clears” if obscuration level drops below alarm threshold.

K. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory and print out the final adjusted values on system printer.

L. Transmission to Proprietary Supervising and Remote Alarm Receiving Stations: Automatically transmit alarm, supervisory, and trouble signals to the dedicated supervising stations.

M. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.5 EMERGENCY VOICE-ALARM COMMUNICATION SYSTEM

A. General: NFPA 72 compliant, combination one-way In-Building Fire Emergency Voice / Alarm Communication and Mass Notification system; digital, dual channel, for automatic and / or manual emergency voice messaging of fire or other emergency conditions. Modules and amplifiers mounted on common cabinet chassis with fire alarm equipment and distributed system architecture with central audio controller and distributed amplifier arrays connected via digital voice audio risers.

B. Controller: Digital, dual channel, digitized alarm tones and digitally recorded voice messages stored in on-board memory; inputs for microphone and auxiliary audio inputs; with local speaker and volume controls and switch / LED audio control modules for operation and indication of system functions.

C. Tones and Messages: Selectable stored evacuation tones, standard digitally pre-recorded voice messages and digitally recorded custom voice messages.

1. Standard digitally recorded messages. Coordinate with manufacturer and owner requirements:

    a. “Fire Emergency”.
    b. “Shelter-In-Place”.
    c. “Storm/Weather Shelter”.
    d. “Tornado Warning”.
    e. “Bomb Threat”.
    f. “Emergency Alarm”.
    g. “All Clear”.
    h. “Emergency Communication System Test”.

2. Direct Live Paging Messages:

    a. “All Call” to direct the page messages to all areas in the building, overriding all other messages and tones.
    b. “Page to Evacuation Area” to direct the message to the evacuation area(s) in the building, overriding all other messages and tones.
    c. "Page to Alert Area" to direct page messages to the area(s) in the building receiving the alert message and tones, overriding all other messages and tones.

3. Paging Zones shall be separated to the following area(s):

    a. Floor by Floor
    b. Server Hall (DC).
    c. Electrical Building (EB).
    d. Facility Support Building (FSA).
    e. Central Utility Building (gCUB).
    f. Chemical Treatment Building (CTB).

D. Amplifiers: UL 1711, digital, dual channel, power-limited 25 or 70 VRMS, on-board test switches and indicators.

1. Spare Capacity: 20%.
2. Self-Backup Mode: Automatically reroute NACs connected to a disabled amplifier channel to remaining active amplifier channel(s).
3. Degrade Mode: On-board temporal pattern horn tone for default backup signaling over connected NACs.

E. Supervision: Digital communication between amplifiers and controller for supervision and annunciation of components status. Amplifier failure shall initiate automatic switchover to backup / alternate amplifier.

F. Status Annunciator: Indicate the status of various voice/alarm speaker zones.

G. Enclosure: Flush-mount cabinet, arranged as stand-alone operating console or as integral to fire alarm system remote annunciator as indicated on Drawings.

2.6 LOCAL OPERATING CONSOLES

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications; and voice messaging. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals, microphone and paging controls for voice messaging.

C. Paging Station: Remote microphone and audio control switch / LED modules matching operation and functionality of main system audio controller.

1. Enclosure: Flush-mount cabinet, arranged as stand-alone paging station or as integral to fire alarm system remote annunciator as indicated on Drawings.

2.7 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bosch Security Systems Inc
2. Digitize, Inc.
3. Edwards Systems Technologies (EST); a United Technologies Corp. Company.
4. Keltron Corp.
5. Notifier; a Honeywell company.
6. Siemens Building Technologies, Inc.; Fire Safety Division.

B. General: UL 864 digital alarm communicator transmitter (DACT) compatible with supervising station receiving equipment; module mounted within FACU cabinet or within stand-alone enclosure; with onboard status LED indicators for component and signal transmission status.

C. Signal Input Connections: Serial connection to host FACU.

D. Signal Transmission Connections: Primary and secondary loop-start telephone lines; programmable such that both phone lines report to the same telephone number, or such that each phone line reports to a different telephone number.

E. Transmission Format: Selectable for Contact ID, SIA, or 4/2 Pulse formats.

F. Supervision: DACT system trouble status supervised by host FACU via serial interface or DACT auxiliary contacts.

G. Self-Test: Conducted automatically every 24 hours with report transmitted to supervising stations.

H. Programming: Remotely via serial interface or integral programming keypad with LED display.

I. Power Supply: Primary 24-V dc obtained from premises AC power supply or host FACU power supply module. Standby 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch provided with DACT unit or as part of host FACU standby power supply system.

2.8 IP COMMUNICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bosch Security Systems Inc
2. Digitize, Inc.
3. Edwards Systems Technologies (EST); a United Technologies Corp. Company.
4. Keltron Corp.
5. Notifier; a Honeywell company.
6. Siemens Building Technologies, Inc.; Fire Safety Division.

B. General: UL 864 IP-dialer-capture module compatible with supervising station receiving equipment; module within stand-alone enclosure; with onboard status LED indicators for component and signal transmission status.

C. Signal Input Connections: Serial connection to host FACU or telephone line connections to host FACU-DACT.

D. Signal Transmission Connections: 10/100 Base network ethernet reporting to primary and secondary IP addresses; dynamic DCPH or static IP supported.

E. Transmission Format: Selectable for Contact ID, SIA, or 4/2 Pulse formats converted to encrypted UDP protocol data transmission.

F. Supervision: IP Communicator system trouble status supervised by host FACU via serial interface, FACU-DACT telephone line interface, or IP Communicator auxiliary contacts.

G. Self-Test: Supervisory heartbeat signal of no less than once every 90 seconds to supervising station to ensure multiplexed level line supervision.

H. Programming: Remotely via serial interface or integral programming keypad with LED display.

I. Power Supply: Primary 24-V dc obtained from premises AC power supply or host FACU power supply module. Standby 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch provided with DACT unit or as part of host FACU standby power supply system.

2.9 REMOTE POWER SUPPLIES

A. Description: Remote power supply for notification appliance circuits and supervised auxiliary power to field devices.

1. Visual notification: Capable of synchronization as “sync-generator” or “sync-follower”.
2. Supervision: Output contacts for supervision of power supply trouble status.
3. Primary Power: 24-V dc obtained from 120-V ac service.
4. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
5. Spare Capacity: 20%.

2.10 MANUAL FIRE-ALARM BOXES

A. General: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral or attached addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.
3. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

B. Emergency Alarm Applications

1. Comply with requirements for manual fire alarm boxes except with yellow finish and raised lettering indicating “EMERGENCY” or similar description applicable to chemical spill emergency conditions.

a. Acceptable alternative: supervised conventional plunger-type push button device with guard, yellow finish and suitable lettering.

2.11 SYSTEM DETECTORS - GENERAL

A. General: Analog addressable detectors for sensing of smoke, heat, and similar products of combustion; listed as compatible with fire alarm system control unit and with integral addressable module capable of two-way analog communication with fire alarm control unit permitting remote sensitivity control, identification of device address, alarm status, trouble status, and trending of maintenance data.

B. Detector Housings: Low profile, white-polycarbonate plastic impact resistant, and flame-retardant detector head for mounting into twist-lock base; with LED type indicating detector status-polling (flashing) or in operation (constant).

C. Detector Bases: Ceiling- and wall-mount, low profile, white-polycarbonate plastic impact resistant, and flame-retardant twist-lock fixed base; with terminals for connection to SLC.

1. Auxiliary Detector Bases: Optional bases furnished to perform supplemental functions at the detector.

a. Sounder bases to provide local audible alarm at detector; 24-V dc.
b. Relay bases for output control of connected equipment.
c. Isolation bases to isolate short circuit faults on SLC.

D. Remote Alarm Indicators (RAI): LED visual indicator in flush-mount plate, connected to corresponding detector base terminals for remote indication of detector alarm.

E. Remote Test Station (RTS): RAI with key operated test switch for remote detector testing.

F. Operating Voltage: 24-V dc nominal for detectors and auxiliary bases; 120-V ac rated contacts for relay bases as per application.

G. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

2.12 SYSTEM SMOKE DETECTORS

A. UL 268, photoelectric spot-type with insect-screen protected sensing chamber; for installation in twist-lock system bases.

B. Operating Temperature Range: 32 - 100°F (0 - 38°C).

C. Operating Humidity Range: 10 - 95% RH.

D. Sensitivity Range: 0.2 - 3.7% obs/ft.

E. Air Velocity Rating: 0 - 4,000 fpm (0 - 1220 mpm).

F. Duct-Smoke Detector Housings:

1. UL 268A, listed for use with UL 268 photoelectric system smoke detector; for mounting on square and round ducts; with and without integral output relays.
2. In-duct Type:

    a. For installation of spot-type system smoke detector within duct. Includes external duct mounting box with translucent cover, detector mounting stem and base attachment, and gaskets.
    b. Air Velocity Range: 0 - 4,000 fpm (0 - 1,220 mpm).

3. Sampling Tube Type:

    a. For installation of spot-type system smoke detector within external duct housing connected to internal duct sampling tubes. Includes external duct housing with translucent cover, wiring terminal blocks, gaskets, and sampling and exhaust tubes.
    b. Air Velocity Range: 300 - 4,000 fpm (91 - 1,220 mpm).
    c. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

4. Sampling Tube Type (Weatherproof):

    a. Same as “Sampling Tube Type” except with NEMA 250, Type 4X sensor housing; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
    b. External Air Temperature Rating: -40 - 158°F (-40 - 158°C).

2.13 SYSTEM HEAT DETECTORS

A. General: Comply with UL 521.

1. Fixed Temperature Type: Actuated by temperature that exceeds a fixed temperature of 135 deg F unless other temperature rating(s) are indicated on Drawings.
2. Rate of Rise: Actuated by a rate of rise that exceeds 15 deg F per minute unless other temperature rating(s) are indicated on Drawings.

2.14 NOTIFICATION APPLIANCES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Wheelock.
2. Edwards Signaling; a United Technologies Corp. company.
3. Siemens Industry, Inc.; Fire Safety Division.
4. System Sensor.

B. General: Connected to notification appliance signal circuits for NFPA 72 public and private operating mode audible-intelligible and / or visible signaling to building occupants protected by the fire alarm system; including combination audible-intelligible / visible, audible-intelligible-only, and visible-only appliances as indicated on Drawings.

1. Mounting: Wall or ceiling mount as indicated on Drawings.
2. Housing: Thermoplastic, impact resistant, and flame retardant.
3. Finish: White with contrasting red engraved lettering unless otherwise noted.
4. Identification: "ALERT", obtain Authority Having Jurisdiction approval.
5. Weatherproof: Gasketed housing / backbox for applications subject to increased humidity or condensation.

C. Audible and Intelligible Notification Appliances (Speakers): UL 1480, 25 or 70 nominal VRMS, listed sound pressure level of 90 dBA measured at 10 feet.

1. Frequency Range: 400 to 4000 Hz.
2. Wattage Taps: Field selectable 0.125 W, 0.25 W, 0.50 W, 1.0 W, 2.0W

D. High-Range Audible and Intelligible Notification Appliances (Double Re-entrant Speakers):

1. UL 1480, 25 or 70 nominal VRMS, listed sound pressure level of 102 dBA measured at 10 feet.
2. Frequency Range: 400 to 14000 Hz.
3. Wattage Taps: Field selectable 0.9, 1.8 W, 3.8 W, 7.5 W, 15.0 W.
4. Finish: Red.
5. Re-entrant speakers shall be installed in the following areas: Server Floor.

E. Visible Notification Appliances: UL 1971, xenon strobe type and/or LED, with clear polycarbonate lens mounted on an aluminum faceplate and field selectable candela output. Comply with Drawings for appliance candela output and mounting location.

1. Strobe flashing shall be in a temporal pattern, synchronized throughout as required by NFPA 72 and ADA Accessibility Guidelines.
2. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.

F. Bells: UL 464; 6-inch diameter, vibrating motor type, 24-V dc; for interior and exterior applications.

G. Flashing Beacons: UL 1638; 6-inch diameter, red lens, 24 Vdc; for interior and exterior applications.

1. Beacon shall be installed on the Exterior Site Fire Pump House for visual notification of fire pump house running.

H. Emergency Alarm System Applications

I. Comply with "Notification Appliances" Article for combination horn/strobe appliances except white finish with amber lens, "EMERGENCY" lettering, and constant audible tone that is distinct from fire emergency.

2.15 ADDRESSABLE INTERFACE MODULES

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Output contact ratings to match controlled equipment.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Control / Relay Module: Capable of providing a direct output signal to controlled equipment or device.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

2.16 FAULT ISOLATION MODULES

A. Module capable of sensing and isolating SLC short circuit faults.

2.17 NETWORK COMMUNICATIONS

A. In-building fire alarm control unit nodes shall be connected by a peer-to-peer communications network (data and voice).

2.18 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V dc. (Provided by the Building Access Control System).

2.19 TRANSIENT VOLTAGE SURGE SUPPRESSORS

A. General: The system must be equipped with protective devices to prevent damage or nuisance alarms by nearby lightning strikes, stray currents, or voltage transients.

B. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. On AC input:

a. Transtector Systems, Inc.
b. Ditek Corp.
c. Leviton Manufacturing Company, Inc.

2. On DC circuits extending outside building:

a. Transtector Systems, Inc.
b. Ditek Corp.
c. Citel America Inc.
d. Emerson Edco

2.20 MAINTENANCE BYPASS SWITCHES

A. Key operated switch or push-button operated switch (integral to fire-alarm control unit) to open connected circuit that permit system testing without operating associated auxiliary fire safety functions. Activated switches will annunciate as a trouble condition at fire alarm control unit. Include trim plate with LED indicators factory-marked “NORMAL” and “DISABLE”.

B. Fire Suppression releasing services shall be provided with a physical switch for each individual pre-action system and not be accomplished by using software.

2.21 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by device manufacturer.
2. Finish: Paint of color to match the protected device.

2.22 FIRE DOCUMENT BOX

A. Enclosure: 18 gauge cold rolled steel with a red powder coat epoxy finish. The cover shall be permanently screened with 1" high lettering "FIRE ALARM DOCUMENTS" with indelible ink; removable hinged door with keyed locking latch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed before installation begins.

B. Confirm fire resistance rating of building construction required to perform as fire alarm system Survivability protection before installation.

C. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with the most restrictive requirements of this Section and applicable Division 26 sections for the installation of low voltage electrical systems.

B. Comply with NFPA 72, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

D. Flush-mount equipment cabinets/back-boxes not located in designated equipment rooms.

E. Flush-mount wall- and ceiling-mounted initiating devices, modules, indicators, and notification appliances unless otherwise indicated.

F. Surface-mount equipment cabinets/back-boxes located in designated equipment rooms.

G. Surface-mount initiating devices, modules, indicators, and notification appliances installed on concrete or masonry unit walls.

H. Surface-mount initiating devices installed to the underside of building structure.

I. Surface-mount or pendant-mount notification appliances installed to the underside of structure.

J. Install fire document box adjacent to main system control unit or other approved location.

K. Install no more than 80 percent of maximum number of addressable devices permitted on each signaling-line circuit by manufacturer.

L. Install isolation modules on signaling-line circuits; maximum twenty (20) addressable devices between isolation modules.

M. Install graphical touch screen annunciators in locations indicated on Drawings.

N. Manual fire alarm boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

O. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, and Drawings for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, and Drawings for heat-detector spacing.
3. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.

P. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

Q. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A.

1. Coordinate mounting location and method of installation of detector housing and sampling tubes with Division 23 Work. Install housing in an accessible location that permits access for maintenance.
2. Sampling Tube Applications: Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.
3. Do not install detector within detector housing during construction. Install detector only during system testing and prior to system turnover.
4. Install remote alarm test station in readily accessible location that does not interfere with other sections of the Work. Coordinate with GC and site local Operations team to confirm these locations meet their requirements.

R. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

S. Install remote power supplies to power visual notification circuits adjacent to voice system amplifier arrays.

T. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling unless ceiling mounted. Install all devices at the same height unless otherwise indicated.

U. Visible Alarm-Indicating Devices: Install at least 6 inches below the ceiling unless ceiling mounted. Install all devices at the same height unless otherwise indicated.

V. Speakers for Voice Notification: Locate speakers for voice notification and adjust wattage taps to satisfy the audibility and intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.

1. Use high-range double re-entrant horn type speakers in Data Center (Server Room).

W. Install exterior weatherproof visual and audible devices at rooftop stairwell exit doors.

X. Install exterior flashing beacons such that they are clearly visible from the primary fire department vehicle access route; and as indicated on Drawings, if applicable. Use a dedicated NAC for each beacon.

Y. Install exterior weatherproof visual devices such that they are clearly visible from the primary fire department vehicle access route; and as indicated on Drawings, if applicable.

Z. Install exterior alarm bells adjacent to each sprinkler fire service room access doorway; and as indicated on Drawings. Use a dedicated NAC for each bell.

3.3 CONNECTIONS

A. Make connections to premises building systems and components via addressable interface modules. Include necessary interface modules, relays, wiring, resistors, and components as required to achieve the input/output sequence of operations performance criteria indicated by the Drawings.

B. Coordinate voltage and current ratings of connected components such that connections and interfaces operate within listed limitations. Use interposing relays where connected loads exceed rating of addressable interface modules.

C. Arrange connections and interfaces such that circuits are monitored for integrity as required by NFPA 72.

D. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

E. Interface to premises systems and components requiring fire alarm supervision of status with IDC’s and addressable interface monitor modules.

F. Interface to premises Preaction Sprinkler solenoids and/or Fire Extinguishing System actuators with addressable interface control modules listed for releasing service.

G. Interface to premises systems and components requiring Emergency Control Function Interface with addressable interface relay modules installed within 36 inches of the interface wiring termination point.

H. Each addressable interface relay module used for Emergency Control Function Interface shall include one (1) set of spare contacts for monitoring connection to the premises Building Management System, Security System, or similar secondary premises system.

I. For each HVAC air distribution unit, coordinate with Division 23 for exact interface requirements, quantity of fan drives, and detailed sequencing for proper shutdown of the associated air distribution equipment.

J. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

K. Install maintenance switches or keypads in the following output control circuits:

1. Man-trap door release.
2. Fire protection rated coiling door release.

3. Building notification appliance circuits (audible and visual) - use maintenance switch with modules and necessary programming logic to achieve building wide supervised “silencing” during testing.
4. Delayed Egress Doors.
5. Elevator Recall Bypass.
6. Air Handler Shutdown Bypass.
7. Damper Bypass.
8. Fire Suppression releasing modules (physical switch only permitted).

3.4 CONNECTIONS TO SITE FIRE ALARM AND ECS SYSTEMS

A. Connect to the site fire alarm optical fiber cabling infrastructure to report address-specific status signals to the site fire alarm monitoring network head-end.

1. With the approval of the owner, where direct reporting of address specific status signals to the site fire alarm head end is not feasible, use an IP communicator (as dialer capture module connected to DACT output) to transmit contact-id format to a compatible IP-DACR located in the site proprietary supervising station or off-site central monitoring station.

B. Connect to the site Emergency Communication System (ECS) head-end via the site fire alarm optical fiber cabling infrastructure using an owner approved voice over internet protocol (VOIP) module configuration.

C. Use owner approved network cards, network modules, I/O modules, network switches, patch panels, cabling, and connectors.

D. Comply with Division 28 “Proprietary Supervising Station Fire Alarm and Emergency Communication System” for network interface modules.

E. Connections to the site fire alarm optical fiber cabling infrastructure shall maintain a token ring arrangement.

F. Connections to the site fire alarm optical fiber cabling infrastructure shall maintain NFPA 72 circuit/pathway Class (operation under fault conditions) and Level (fire resistance).

3.5 CAMPUS FIRE ALARM WORKSTATION AND SITE PANEL MODIFICATIONS

A. Fire alarm system integration to proprietary supervising station equipment shall be performed by fire alarm testing and maintenance contractor/ vendor.

1. Add graphics and initiating devices for the building, following the existing programing and protocol.
2. Modify existing site fire alarm program to include additional fire alarm control units and workstations.
3. Modify existing site emergency communication programming to include building paging capabilities.

B. Contractor is responsible for providing graphical fire alarm backgrounds to owner, for site fire alarm testing and maintenance contractor/ vendor to integrate into master site fire alarm graphical workstation.

C. Testing verification from building to proprietary supervising station shall be coordinated with GC, owner, and site fire alarm maintenance contractor.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in NFPA 72.

B. Provide system programmed ID-address labels on all initiating devices, indicate specific equipment's function for remote testing modules.

C. Install framed instructions in a location visible from fire-alarm control unit.

1. Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

3.7 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the fire-alarm control unit location only. Insulate shield at device location.

3.8 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by construction manager and Authorities Having Jurisdiction (AHJ). Perform 100% functional testing prior to AHJ witness testing. System shall be completely inspected and tested in accordance with NFPA 72 requirements; and placed into normal operating service without system faults or outstanding work prior to requesting AHJ witness testing. Repeat functional testing with AHJ present to the extent required by the AHJ.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
c. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

2. System type detectors shall be tested for their sensitivity compensation head room range (% dirty). Detectors shall not be greater than 20% dirty for their compensation range. Detectors over 20% shall be clean or replaced per the manufacturer’s requirements.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

3.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include twelve (12) months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111

SECTION 283131 - PROPRIETARY SUPERVISING STATION, FIRE-ALARM AND EMERGENCY COMMUNICATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Central fire-alarm control unit.
2. Central emergency voice-alarm communication system.
3. Graphical command workstation.
4. Local Operating Console.
5. Digital alarm communicator transmitter
6. IP - digital alarm communicator receiver.
7. IP / cellular digital alarm communicator transmitter.
8. Network interface modules.
9. System printer.

1.3 DEFINITIONS

A. BMS: Building Management System.

B. FACU: Fire Alarm Control Unit.

C. IDC: Initiating Device Circuit.

D. NAC: Notification Appliance Circuit.

E. NICET: National Institute for Certification in Engineering Technologies.

F. PC: Personal computer.

G. SLC: Signaling Line Circuit.

1.4 SUBMITTALS

A. Comply with NFPA 72 for "Documentation”.

B. Qualification Data: For Designers and Field Technicians.

C. Include NICET certifications and fire alarm system manufacturer training certifications.

D. Product Data: For each type of product, including furnished options and accessories.

E. Sample Warranty: For special warranty.

F. Shop Drawings: For fire alarm system and fire safety control interfaces. Include floor plans, riser diagrams, equipment wiring diagrams, component wiring diagrams, input / output sequence matrix, voltage drop calculations, power supply calculations, amplifier loading calculations, audio dB loss calculations, and conduit fill calculations.

G. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

H. Record Drawings. Provide complete Shop Drawing re-submittal updated to reflect actual final system installation and sequence of operation of all components.

I. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Smoke Detectors and Heat Detectors: Three (3) of each type installed.
2. Detector Bases: Three (3) of each type installed.
3. Audible and Visual Notification Appliances: Three (3) of each type installed.
4. Keys and Tools: One extra set for access to locked or tamper-proof components.
5. Fuses: Two (2) of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.6 QUALITY ASSURANCE

A. Field Technician Qualifications: Personnel trained and certified by fire alarm system manufacturer as an approved technician.

B. Designer Qualifications: Shop drawings and Calculations prepared by personnel certified by NICET as fire alarm Level III or IV technician.

C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Where applicable, components shall be compatible with, and operate as, an extension of existing systems.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1. Specific Agency Requirements for All Products: Underwriters Laboratories (UL) listed and Factory Mutual (FM) Approved.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Construction Manager no fewer than ten (10) days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Construction Manager's written permission.

B. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.8 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five (5) years from the first day of business.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design: Edwards Systems Technologies (EST); a United Technologies Corp. Company.
2. Notifier; a Honeywell company.
3. Siemens Building Technologies, Inc.; Fire Safety Division.

B. Where additional manufacturer listings or basis of design products are indicated, provide products listed and duty rated as compatible with the selected fire alarm and signaling technology platform.

2.2 SYSTEM DESCRIPTION

A. UL 864; non-coded, microprocessor-based addressable proprietary supervising station fire alarm and emergency communication system, which is a complete, supervised system consisting of any of the following: digital alarm communicator receiver, graphical command workstation, emergency communication system, fire alarm control unit and printer in a campus Central Control Room.

B. Transmitting equipment compatible with receiving equipment and UL listed or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

C. Proprietary supervising station fire alarm system listed for combination In-building Emergency Voice Alarm Communications System (EVACS) and Mass Notification System (MNS) service utilizing digital multi-channel technology.

D. Control units, system components, and power supplies inclusive of boards, drivers, and expansion modules necessary to support the specified system performance criteria, minimum quantity of circuits, and NFPA 72 circuit pathway class designations.

E. All components listed for use with the selected fire alarm system technology platform.

F. System circuiting and component power loading to provide minimum specified spare capacities, safety factors, and redundancies.

G. All addressable circuits designed and installed without T-taps.

H. Site Integration.

1. Receive address-specific status signals from the protected premises fire alarm systems connected to the site fire alarm monitoring network.
2. Receive contact-id format signals from protected premises using IP communicators for signal transmission across the site fire alarm monitoring network.

3. Complete functional integration of proprietary supervising station Emergency Communication System (ECS) and site-wide protected premises in-building EVACS / MNS and site outdoor High-Power Speaker Arrays (HPSA) permitting messages and signals originating from the ECS head-end to signal over the protected premises NAC's and outdoor HPSA's.

2.3 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72 for Proprietary Supervising Station Fire Alarm Systems.

B. Operational Performance: Fire alarm system shall process alarm, supervisory, and trouble status signals and perform associated output functions in compliance with NFPA 72, Division 28 and Drawings Input/Output Matrix.

C. Emergency Communication System: Comply with NFPA 72 for combination In-building Emergency Voice Alarm Communications System (EVACS) and Mass Notification System (MNS).

D. Circuit Integrity and Fault Performance: Fire alarm system circuit integrity and functional performance capability under fault conditions shall comply with the NFPA 72 circuit Class designations as specified under Div. 28.

E. Survivability Performance: Fire alarm system fire resistive performance capability shall comply with the NFPA 72 circuit Level designations as specified under Div. 28.

F. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 CENTRAL FIRE-ALARM CONTROL UNIT

A. General: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
2. Include a real-time clock for time annotation of events on the event recorder and printer.
3. Provide communication between the FACU and remote circuit interface panels, annunciators, and displays.
4. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACU shall provide a minimum 500-event history log.

B. Enclosure: Steel, factory-paint red.

1. Mounting: Flush (stud-walls) and surface (masonry unit walls).
2. Door: Hinged, removable, key-lock; with view window or dead-front for remote node application.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

D. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

E. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.
2. Base Capacity: System operation for forty-eight (48) hours under quiescent load plus fifteen (15) minutes operating all alarm notification appliances.
3. Spare Capacity: 20%.

F. Signaling Line Circuits (SLC):

1. Minimum Quantity: One (1), expandable to ten (10).
2. Minimum Capacity: 125 addressable initiating devices and 125 addressable modules (250 addressable devices total) per loop, expandable to 2500).
3. Configuration: Capable of supporting Class A SLC configuration.

G. Notification Appliance Circuits (NAC)

1. Minimum Quantity: Four (4), expandable to eight (8).
2. Minimum Rating: 24V-dc @ 2.0 Amps
3. Public Mode Audible Operation: NFPA 72 three-pulse temporal pattern.
4. Public Mode Visual Operation: Synchronized, UL 1971 strobe pattern.

H. Auxiliary power outputs:

1. Two (2), expandable to five (5) continuous 24V-dc @ 2.0 Amps.
2. One (1) resettable 24V-dc @ 2.0 Amps.

I. Serial Interfaces:

1. RS 485 port(s) for remote annunciators, Ethernet module, or multi-interface module (printer port).

2. USB port(s) for PC configuration.
3. RS 232 port(s) for voice evacuation interface.

J. Smoke-Alarm Verification: Control algorithm(s) permitting smoke detectors to verify alarm obscuration levels upon initial alarm. After verification time period is completed, detector alarm status "latches" if obscuration level remains above alarm threshold or "clears" if obscuration level drops below alarm threshold.

K. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory and print out the final adjusted values on system printer.

L. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.5 CENTRAL EMERGENCY VOICE-ALARM COMMUNICATION SYSTEM

A. General: NFPA 72 compliant, combination one-way In-Building Fire Emergency Voice / Alarm Communication and Mass Notification system; digital, dual channel, for automatic and / or manual emergency voice messaging of fire or other emergency conditions. Modules and amplifiers mounted on common cabinet chassis with fire alarm equipment and distributed system architecture with central audio controller and distributed amplifier arrays connected via digital voice audio risers.

B. Controller: Digital, dual channel, digitized alarm tones and digitally recorded voice messages stored in on-board memory; inputs for microphone and auxiliary audio inputs; with local speaker and volume controls and switch / LED audio control modules for operation and indication of system functions.

C. Tones and Messages: Selectable stored evacuation tones, standard digitally pre-recorded voice messages and digitally recorded custom voice messages.

1. Standard digitally recorded messages. Coordinate with manufacturer and owner requirements:

a. "Fire Emergency"
b. "Shelter-In-Place"
c. "Storm/Weather Shelter"
d. "Tornado Warning"
e. "Bomb Threat"
f. "All Clear"
g. "Emergency Communication System Test"

2. Direct live paging messages as follows:

   a. “All Call” to direct the page messages to all areas in the building, overriding all other messages and tones.
   b. “Page to Evacuation Area” to direct the message to the evacuation area(s) in the building, overriding all other messages and tones.
   c. "Page to Alert Area" to direct page messages to the area(s) in the building receiving the alert message and tones, overriding all other messages and tones.
   d. "Page to Balance Buildings" to direct page messages to the area(s) on the site NOT receiving either the evacuation area or alert area messages.

D. Amplifiers: UL 1711, digital, dual channel, power-limited 25 or 70 VRMS, on-board test switches and indicators.

1. Spare Capacity: 20%.
2. Self-Backup Mode: Automatically re-route NACs connected to a disabled amplifier channel to remaining active amplifier channel(s).
3. Degrade Mode: On-board temporal pattern horn tone for default backup signaling over connected NACs.

E. Supervision: Digital communication between amplifiers and controller for supervision and annunciation of components status. Amplifier failure shall initiate automatic switchover to backup/alternate amplifier.

F. Status Annunciator: Indicate the status of various voice/alarm speaker zones.

G. Enclosure: Flush-mount cabinet, arranged as stand-alone operating console or as integral to fire alarm system remote annunciator as indicated on Drawings.

2.6 GRAPHICAL COMMAND WORKSTATION

A. The graphical command workstation shall support a minimum of eighty (80) networked fire alarm control units using IP protocol communications. Additionally, the graphical command workstation shall support a digital alarm communicator receiver (DACR) unit to monitor third-party fire systems via Ethernet. The workstation shall be UL listed to command and control all fire alarm networks and equipment supplied under this contract.

B. Provide a personal computer-based color graphical command workstation with an interactive operator’s terminal. The terminal shall serve as the primary operator’s interface and a fire alarm network node capable of complete system-wide status reporting and control. Control functions shall include System Drill, Reset, Silence, and status control of each individual point via the interactive touch-screen operator’s display. The operator’s terminal shall provide logging of event histories and the generation of maintenance reports. Terminal hardware shall consist of the following:

1. An industrial-grade personal computer with a minimum 2 GHz PIII CPU, 80.0 gigabyte hard drive, 2 giga-bite or REM memory, 32-megabyte video card, CD ROM, a serial mouse, and keyboard.

2. A minimum 32-inch flat panel monitor with high resolution touch-screen operator's control interface.
3. A minimum 22-inch flat panel with high resolution for operator's control interface to be mounted at security operator desk.
4. Shall support the import of graphic CAD files in .DXF format, as well as field editing of operator's data screens.
5. The terminal shall support up to 5 zoom levels of graphic display with point identification of each device on the system. Levels shall include site plan, floor levels, zones, point identification and custom point-specific message screens.
6. Active points shall annunciate by user-defined Touch Sensitive Areas (TSA's). An alarm point will cause a flashing red TSA border, with an accompanying audible signal. Upon touching the TSA the screen will automatically zoom to the next level. Upon reaching the final device level a full screen of instructional text will be available for operator's instruction, and the alarm may be acknowledged. Subsequent alarms will follow using pre-assigned levels of priority.

C. Functional Performance:

1. Receiving incoming events and transmit event details to web clients and responsible parties.
2. Acknowledging, silencing, and resetting all fire alarm functions.
3. Manually activating, deactivating, enabling, and disabling individual fire alarm points.
4. Generating status, maintenance, and sensitivity reports for all fire alarm components.
5. Logging all events and operator actions to history for future review.
6. Logging the operator's comments for each event to history with time and date.
7. Transmitting system status to all connected web clients.

D. Uninterruptible Power Supply (UPS) sized to support the graphical command workstation for a minimum of 8 hours.

1. Complying with UL 1481.
2. Approved Manufacturers, Subject to compliance with requirements, provide products by La Marche Manufacturing Company. Substitution requests will be considered.
3. Manufacturer's Approved Products:

    a. La Marche 23" Rack Mounted 48 Vdc UPS System

        1) Model A32S-1.5K-48VBC-A6-8-24.

    b. UL 1481 listed charger rated 25 output at 48 Vdc with 120 Vac, single phase input.

        1) Model A36D-25-48V-ABD1-24L-17210

    c. UL 1481 listed inverter rated 1.5 kVA (12.50 Amps at 120 Vac) with Option 22S - Static Switch.

        1) Model A31-1.5K-48V-A6-24L-01038

    d. P3-RR-P060 23" Relay Rack, 7 feet tall.
    e. P3-RRB-A07A battery tray

f. Batteries: GNB 48 Vdc Marathon front terminal VRLA batteries:

1) Model 24-M12V180FT each consisting of 24 cells, four (4) six-cell units of model M12V180FT rated 180 AH (360 AH total) and sized to provide 45.0 Amps for 8 hours to 1.75 VPC at 77degF to the inverter.

2.7 LOCAL OPERATING CONSOLES

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications; and voice messaging. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals, microphone and paging controls for voice messaging.

C. Paging Station: Remote microphone and audio control switch / LED modules matching operation and functionality of main system audio controller.

1. Enclosure: Flush-mount cabinet, arranged as stand-alone paging station or as integral to fire alarm system remote annunciator as indicated on Drawings.

2.8 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bosch Security Systems Inc
2. Digitize, Inc.
3. Edwards Systems Technologies (EST); a United Technologies Corp. Company.
4. Keltron Corp.
5. Notifier; a Honeywell company.
6. Siemens Building Technologies, Inc.; Fire Safety Division.

B. General: UL 864 digital alarm communicator transmitter (DACT) compatible with supervising station receiving equipment; module mounted within FACU cabinet or within stand-alone enclosure; with onboard status LED indicators for component and signal transmission status.

C. Signal Input Connections: Serial connection to host FACU.

D. Signal Transmission Connections: Primary and secondary loop-start telephone lines; programmable such that both phone lines report to the same telephone number, or such that each phone line reports to a different telephone number.

E. Transmission Format: Selectable for Contact ID, SIA, or 4/2 Pulse formats.

F. Supervision: DACT system trouble status supervised by host FACU via serial interface or DACT auxiliary contacts.

G. Self-Test: Conducted automatically every 24 hours with report transmitted to supervising stations.

H. Programming: Remotely via serial interface or integral programming keypad with LED display.

I. Power Supply: Primary 24-V dc obtained from premises AC power supply or host FACU power supply module. Standby 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch provided with DACT unit or as part of host FACU standby power supply system.

2.9 IP – DIGITAL ALARM COMMUNICATOR RECEIVER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design: Bosch Security Systems Inc.
2. Digitize, Inc.
3. Keltron Corp.

B. General: Digital alarm communicator receiver shall be acceptable to the proprietary supervising station and shall comply with UL 864 and NFPA 72.

C. Functional Performance:

1. Unit shall receive an alarm, supervisory, or trouble signal from digital alarm communicator transmitter using a WAN/LAN network and IP protocol.
2. The LAN/WAN Gateway Communications shall include:

a. Bi-directional communications with fire alarm control unit via the digital alarm communicator transmitter.
b. Supervised network automation computer links.
c. Up to 3200 network accounts (depending on supervision interval).
d. Ethernet communications.

D. Central Processing Unit:

1. Re-programmable FLASH memory for software upgrades and future product enhancements.
2. Direct interface to graphical command workstations.
3. Event acknowledgement can be automation or manual push-button.
4. 20,000 event history buffer.

E. Serial Interfaces:

1. RS-232 port(s) for printer.
2. RS-485 port(s) for remote interface.
3. USB port(s) for PC configuration.

F. Reception:

1. Unit shall provide fire alarm control unit supervision using periodic heartbeats (polling, typically one every 90 seconds) in order to monitor the continuity of the network link.
2. If the programmable time window for a specific network account expires without a valid message being received, the digital alarm communicator receiver shall generate a trouble message, indicating a loss of supervision for the indicated fire alarm control unit.
3. If a valid message is subsequently received, the digital alarm communicator receiver shall generate a message indicating a restoration of supervision for the indicated fire alarm control unit.

G. Local functions and display at the digital alarm communicator receiver shall include the following:

1. LCD display for manually reviewing status and event information.
2. A self-contained or externally mounted switch shall manually place the receiver on emergency battery power for test purposes.
3. Communications failure with digital alarm communicator transmitters.
4. Connections for an external printer and graphical command workstation.

2.10 IP / CELLULAR DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bosch Security Systems Inc.
2. Digitize, Inc.
3. Edwards Systems Technologies (EST); a United Technologies Corp. Company.
4. Keltron Corp.
5. Notifier; a Honeywell company.
6. Siemens Building Technologies, Inc.; Fire Safety Division.

B. General: UL 864 IP / Cellular-dialer-capture module compatible with supervising station receiving equipment; module within stand-alone enclosure; with onboard status LED indicators for component and signal transmission status.

C. Signal Input Connections: Serial connection to host FACU or telephone line connections to host FACU-DACT.

D. Signal Transmission Connections:

1. 10/100 Base network Ethernet reporting to primary and secondary IP addresses; dynamic DCPH or static IP supported.
2. CDMA, GPRS, HSPA+ or 3G/EVDO cellular communicators to cellular carriers.

E. Transmission Format: Selectable for Contact ID, SIA, or 4/2 Pulse formats converted to encrypted UDP protocol data transmission.

F. Supervision: IP Communicator system trouble status supervised by host FACU via serial interface, FACU-DACT telephone line interface, or IP Communicator auxiliary contacts.

G. Self-Test: Supervisory heartbeat signal of no less than once every 90 seconds to supervising station to ensure multiplexed level line supervision.

H. Programming: Remotely via serial interface or integral programming keypad with LED display.

I. Power Supply: Primary 24-V dc obtained from premises AC power supply or host FACU power supply module. Standby 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch provided with DACT unit or as part of host FACU standby power supply system.

2.11 NETWORK INTERFACE MODULES

A. Network IO Modules:

1. General: Where the graphical command workstation must interface with third party fire alarm equipment over the fire alarm network, a network IO module shall be used.
2. The module shall provide four (4) unsupervised inputs and four (4) NO relay contacts.
3. Network IO module inputs shall be configurable as incoming events on the workstation and IO relays shall be operated by commands from the workstation.
4. Network communications shall be supervised by the graphic command workstation.
5. The network IO module shall operate on a nominal 24 Vdc supplied from a battery backed up fire alarm control unit or booster power supply to ensure power to the switch is supervised and reliable.

B. Voice over IP (VoIP) Modules:

1. General: Where the central FACU and graphical command workstation must interface with third party fire alarm emergency communication system equipment over the fire alarm network, the VoIP module shall be used.
2. Network audio connectivity shall consist of a supervised encoder/decoder capable of encoding/decoding MP3, WMA, G.711 and PCM data streams in HTTP, UDP or RTP format, depending on its application.
3. The encoder input audio shall be generated from dedicated FACU amplifier and attenuated to the correct level using an audio bridge.
4. Analog audio from the decoder shall connect to the FACU audio source unit input. Signal monitoring shall be provided by supervisory modules.
5. The VoIP module shall operate on filtered-regulated 24 VDC power derived from the FACU power supply, ensuring a reliable and monitored power source.
6. The VoIP module shall be equipped with:

    a. Line-level audio output.
    b. 10/100 Base-T Mbit Automatic Ethernet port.
    c. RS232, 115,200 baud communication port.
    d. Normally open relay rated at 500 mA @ 24 Vdc.
    e. Reset button.

C. IP Network Switches:

1. The IP network switches shall be industrial grade auto-negotiating switching hubs. Switch shall be UL864 listed, shall provide four (4)10/100 Mbps shielded RJ-45 connectors for twisted pair (Ethernet) connections and two 100 Mbps multi-mode fiber ports.
2. The switches shall operate on a nominal 24 Vdc supplied from a battery backed up fire alarm control unit or booster power supply to ensure power to the switch is supervised and reliable.
3. Switches shall provide LED indicators for data rate, activity/link integrity, power and loop detection.

D. Media Converter Modules:

1. RS232 to LAN / WAN Network:

a. Interface module shall be a UL 864 Listed industrial grade 10/100 Base-T Ethernet device server.
b. The interface shall operate on a nominal 24 Vdc supplied from a battery backed up fire alarm control unit or booster power supply to ensure power to the interface is supervised and reliable.
c. The interface shall have diagnostic LEDs on the front of the unit make it easy to determine its status and incorporate flash ROM memory facilitating upgrading the operating firmware.

2.12 SYSTEM PRINTER

A. Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

1. Printer shall print a minimum of 80 characters per line.
2. Print speed shall be minimum 120 characters per second.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed before installation begins.

B. Confirm fire resistance rating of building construction required to perform as fire alarm system Survivability protection before installation.

C. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with the most restrictive requirements of this Section and applicable Division 26 sections for the installation of low voltage electrical systems.

B. Comply with NFPA 72, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

3.3 CONNECTIONS

A. Make connections to premises building systems and components via addressable interface modules. Include necessary interface modules, relays, wiring, resistors, and components as required to achieve the input/output sequence of operations performance criteria indicated by the Drawings.

B. Coordinate voltage and current ratings of connected components such that connections and interfaces operate within listed limitations. Use interposing relays where connected loads exceed rating of addressable interface modules.

C. Arrange connections and interfaces such that circuits are monitored for integrity as required by NFPA 72.

D. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

E. Interface to premises systems and components requiring fire alarm supervision of status with addressable interface monitor modules.

F. Interface to premises systems and components requiring Emergency Control Function Interface with addressable interface relay modules installed within 36 inches of the interface wiring termination point.

G. Each addressable interface relay module used for Emergency Control Function Interface shall include one (1) set of spare contacts for monitoring connection to the premises Building Management System, Security System, or similar secondary premises system.

3.4 CONNECTIONS TO SITE FIRE ALARM AND ECS SYSTEMS

A. Connect the workstation to the site fire alarm optical fiber cabling infrastructure to receive address-specific status signals from the protected premises fire alarm systems connected to the site fire alarm monitoring network.

B. Connect the IP-DACR to the site fire alarm optical fiber cabling infrastructure to receive contact-id format signals from protected premises using IP communicators for signal transmission across the site fire alarm monitoring network.

C. Connect the Emergency Communication System (ECS) head end to the site fire alarm optical fiber cabling infrastructure using a Voice Over Internet Protocol (VOIP) technology configuration.

D. Existing Protected Premises Buildings: Connect each protected premises in-building fire alarm network to the site fire alarm monitoring network and ECS head-end. Add necessary IP communicators, VOIP modules, and related connections at each existing protected premises interface to the site fire alarm optical fiber cabling infrastructure.

E. Existing Buildings (EVACS/MNS): Connect each protected premises combination In-building Emergency Voice Alarm Communications System (EVACS) and Mass Notification System (MNS) to CCR head-end ECS equipment via the campus fire alarm optical fiber network using VOIP module system configuration.

F. Use Owner approved network cards, network modules, I/O modules, network switches, patch panels, cabling, and connectors.

G. Connections to the site fire alarm optical fiber cabling infrastructure shall maintain a token ring arrangement.

H. Connections to the site fire alarm optical fiber cabling infrastructure shall maintain NFPA 72 circuit/pathway Class and Level.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in NFPA 72.

B. Provide system programmed ID-address labels on all initiating devices, indicate specific equipment’s function for remote testing modules.

C. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

D. Install framed instructions in a location visible from fire-alarm control unit.

1. Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the fire-alarm control unit location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by Construction Manager and Authorities Having Jurisdiction (AHJ). Perform 100% functional testing prior to AHJ witness testing. System shall be completely inspected and tested in accordance with NFPA 72 requirements; and placed into normal operating service without system faults or outstanding work prior to requesting AHJ witness testing. Repeat functional testing with AHJ present to the extent required by the AHJ.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.

    a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE CONTRACT

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include twelve (12) months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
4. DEMONSTRATION

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283131

SECTION 323119 - METAL GATES [NOTE TO SPECIFIER: NEED TO CONFIRM – THIS ITEM ONLY OCCURS IF PROJECT HAS A DUMPSTER ENCLOSURE]

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Swing gates.

B. Related Requirements:

1. Section 055000 “Metal Fabrications” for metal bollards.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For gates.

1. Include plans, elevations, sections, gate locations, post spacing, and mounting details.

C. Samples: For each gate material and for each color specified.

PART 2 - PRODUCTS

2.1 SWING GATES

A. Dumpster Enclosure Gate: Welded aluminum frame with vinyl infill.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Digger Specialties Inc.; Dumpster Enclosure Gate, or approved equal.

B. Gate Configuration: Double leaf.

C. Gate Frame Height: As indicated.

D. Gate Opening Width: As indicated.

E. Vinyl Infill: 7/8 x 6 x 0.050 inch, snap-lock tongue and groove.

1. Color: As selected by Architect from manufacturer’s full range.

F. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf. Provide drop-pin cane bolts for pairs of gates.

G. Hinges: Adjustable bollard hinge for 6-5/8 inch round posts.

1. Information on metal bollards is indicated in Section 055000 “Metal Fabrications.”

H. Aluminum Finish: Powder coating.

2.2 ALUMINUM

A. Aluminum, General: Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.

B. Extrusions: ASTM B221, Alloy 6063-T5.

C. Tubing: ASTM B429/B429M, Alloy 6063-T6.

D. Plate and Sheet: ASTM B209, Alloy 6061-T6.

E. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.

F. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.3 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2604. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.3 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION 323119